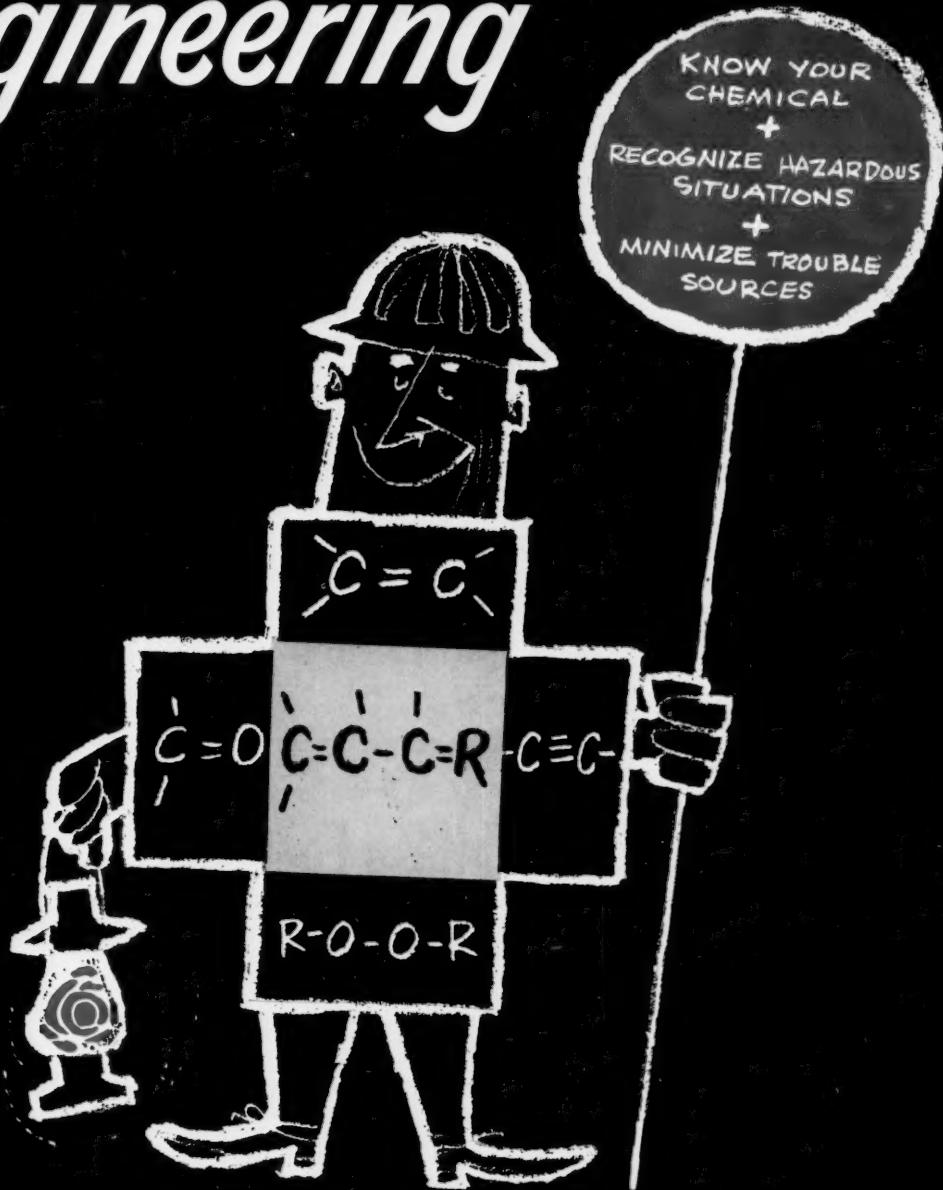


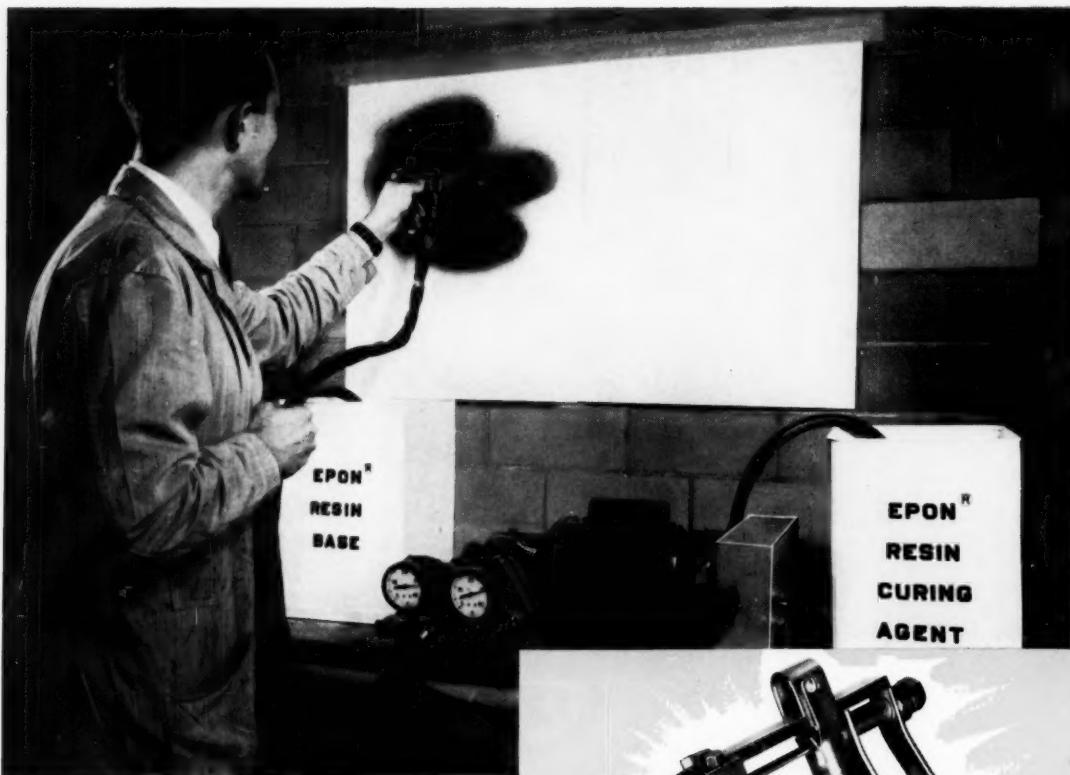
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▲ Shell Chemical technician demonstrates new high solids spray gun. Shell introduced the GUSCO Process Equipment at the 1958 Paint Show, with continuous demonstrations.

New portable GUSCO Process Equipment made by A. Gusmer Inc., Woodbridge, New Jersey, supplies Epon resins and curing agent in proper proportion from portable heating and pumping machine. Coating resists acids and alkalies, aliphatic and aromatic hydrocarbon solvents. ▶



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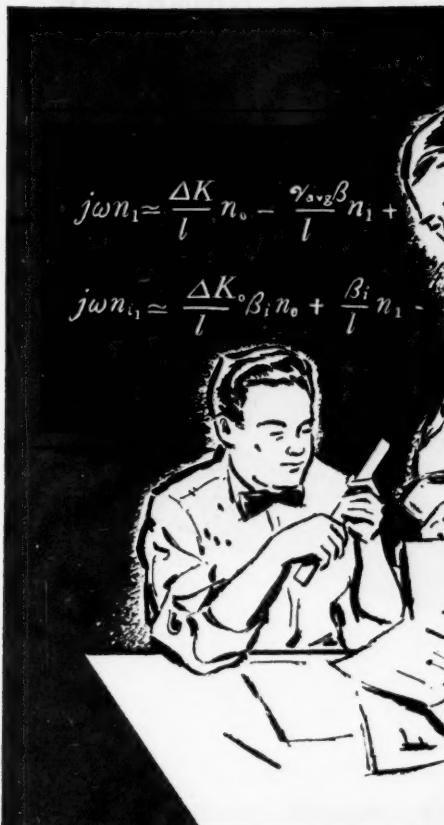
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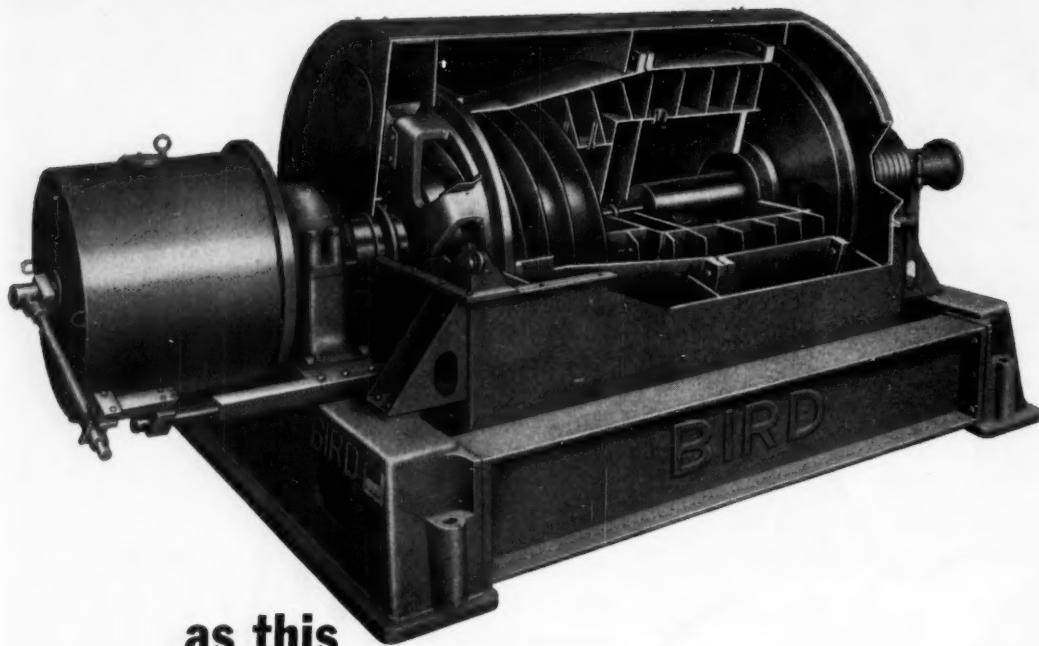
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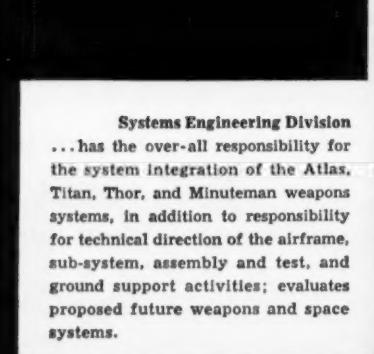


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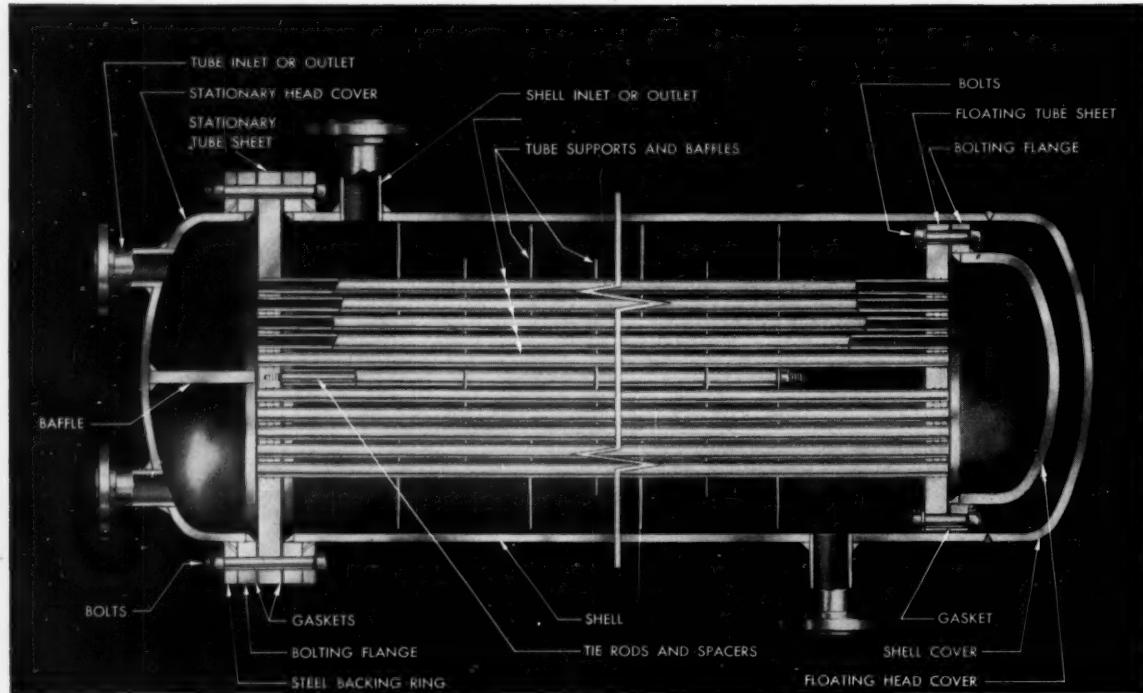
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of maintenance methods. For relatively soft or loose scale, water jets and brushes are usually satisfactory. Wet sandblast- ing as well as chemical cleaners may be used effectively.

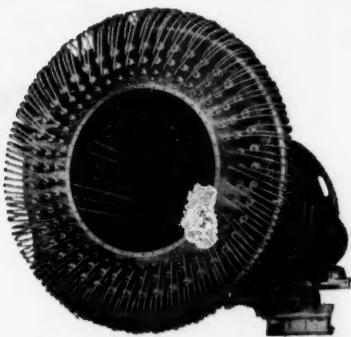
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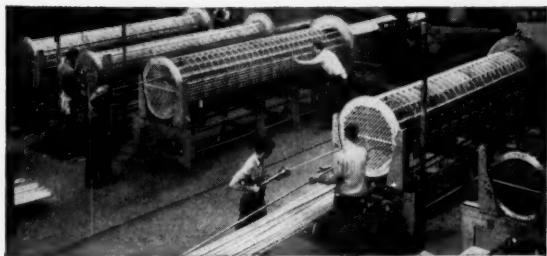
ALCOA is conducting a series of engineering conferences on process industries applications of aluminum during 1959 in a number of major cities. Contact your nearest ALCOA sales office for full particulars and dates.



For certain processes where corrosive or sensitive materials are involved, it is often advisable to use aluminum for entire heat exchanger systems to avoid system corrosion and contamination of the product. A typical all-aluminum heat exchanger is shown here. Alloy recommendations are given in the table opposite.



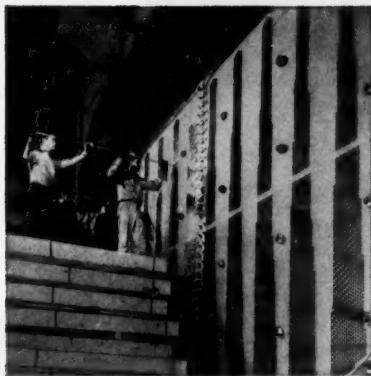
Alcoa Aluminum Tubing protects color in the world's largest rotary steam-tube drier. The drier measures 10 ft in diameter by 100 ft long.



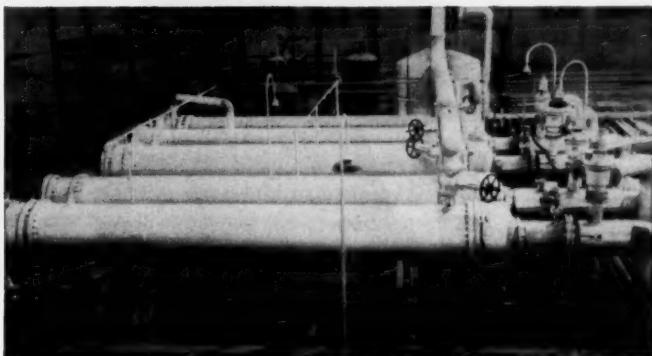
Construction of a heat exchanger utilizing Alcoa Aluminum Tube. Superior working properties plus the cold-drawing method by which Alcoa seamless heat exchanger tubes are produced results in close dimensional tolerances and smooth inside and outside surfaces.



This all-aluminum dephlegmator in a large coke plant is used for the regeneration of ammonia liquor in a hydrogen sulfide scrubbing operation. Aluminum tubes lasted five times longer than steel tubes in a similar use.



A Midwest utility saved 50 per cent on tubing costs by using Alcoa Aluminum instead of admiralty for tubing in this surface condenser. Successful operation of this unit has led to the installation of similar units by other utilities. This use demonstrates aluminum's economy and superior resistance to ammonia, carbon dioxide and hydrogen sulfide.



Alloy Recommendations for Aluminum Heat Exchanger Construction

	Alcoa Designation	ASTM Specification*	Alloy
Tubes	3003-H14	B234	M1A
Alclad (inside)	3003-H14	B234	clad M1A
Alclad (outside)	3003-H14	B234	clad M1A
Alclad (both sides)	3003-H14	B234	clad M1A
	6061-T6	B234	GS11A
	6061-T6	B234	GS11C
	3004-H112	B178	M1A
	6061-T6	B178	clad MG11A
Tube Sheets	3004-H112	B178	GS11A
	6061-T6	B178	clad GS11A
Baffles	3003-H14	B178	M1A
Tie Rods	Alclad 3003-H14	B178	clad M1A
Shells & Headers	6061-T6	B273	GS11A
	6061-T6	B178	M1A
	Alclad 3003-H112	B178	clad M1A
	3004-H112	B178	MG11A
	5052-H112	B178	GR20A
	5154-H112	B178	GR40A
Fittings	3003-F	B274	M1A as applicable
	6061-T6	B274	GS11A as applicable
Flanges	6061-T6	B247	GS11A as applicable

*Only the basic number is shown since Alcoa products are manufactured to the latest issue of the specification. The complete number would indicate the year of issue.

Aluminum Company of America
871-D Alcoa Building, Pittsburgh 19, Pa.

Please send me the following literature covering Alcoa Aluminum in heat exchanger and other applications in the process industries.

- 10186 Alcoa Aluminum Heat Exchanger Tubes
- 20437 Aluminum Alloy Heat Exchangers in the Process Industries
- 10460 Process Industries Applications of Alcoa Aluminum
- 20849 Resistance of Aluminum Alloys to Weathering and Resistance of Aluminum Alloys to Chemically Contaminated Atmospheres
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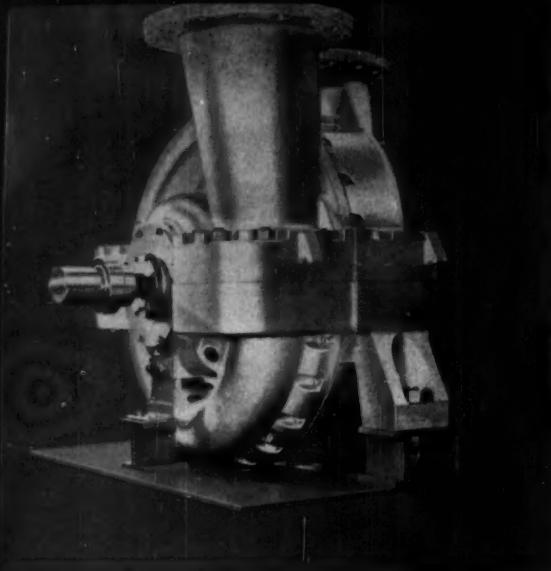
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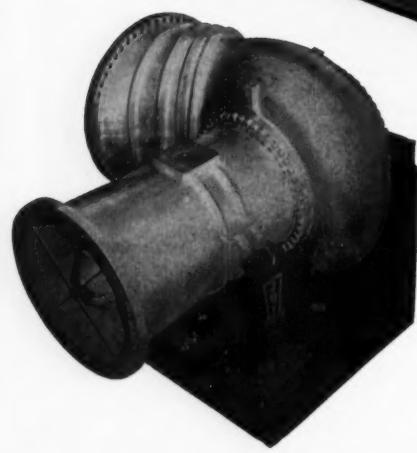
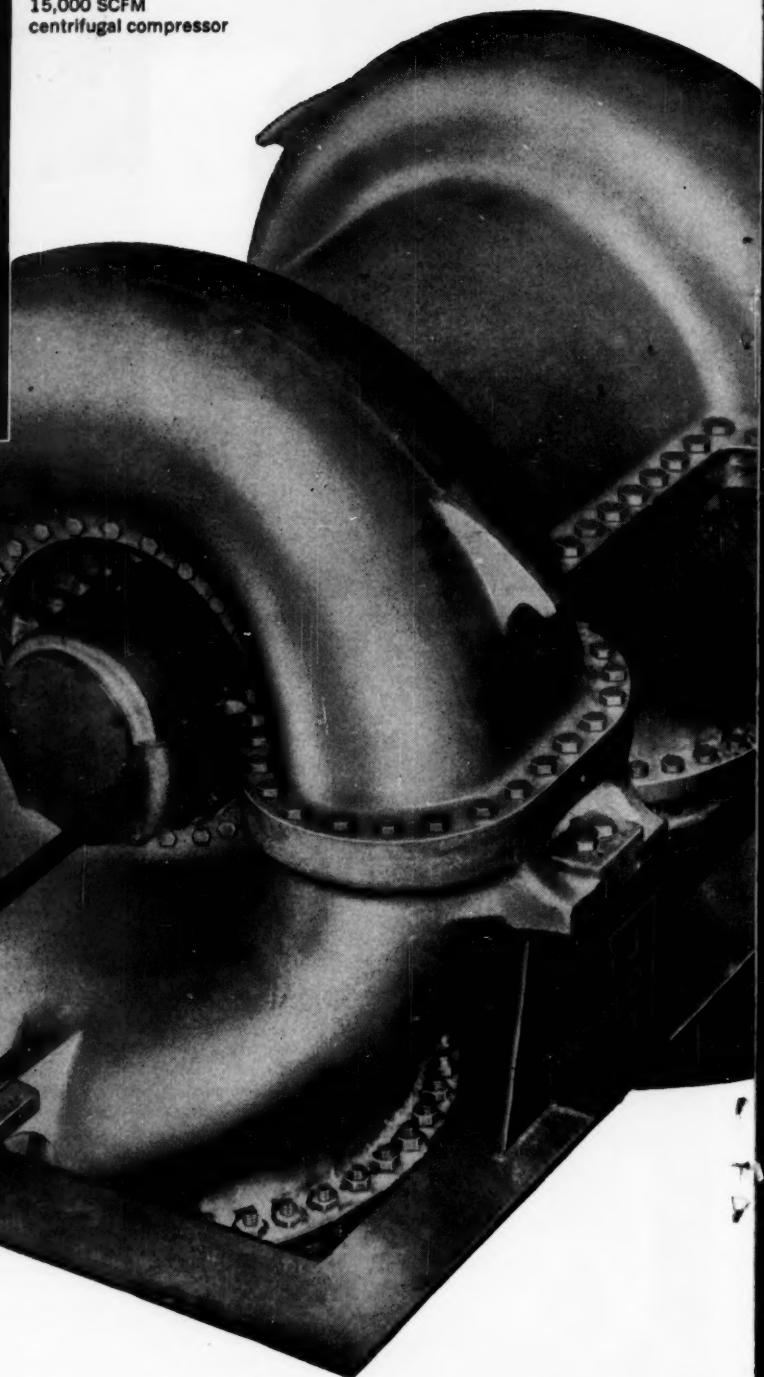
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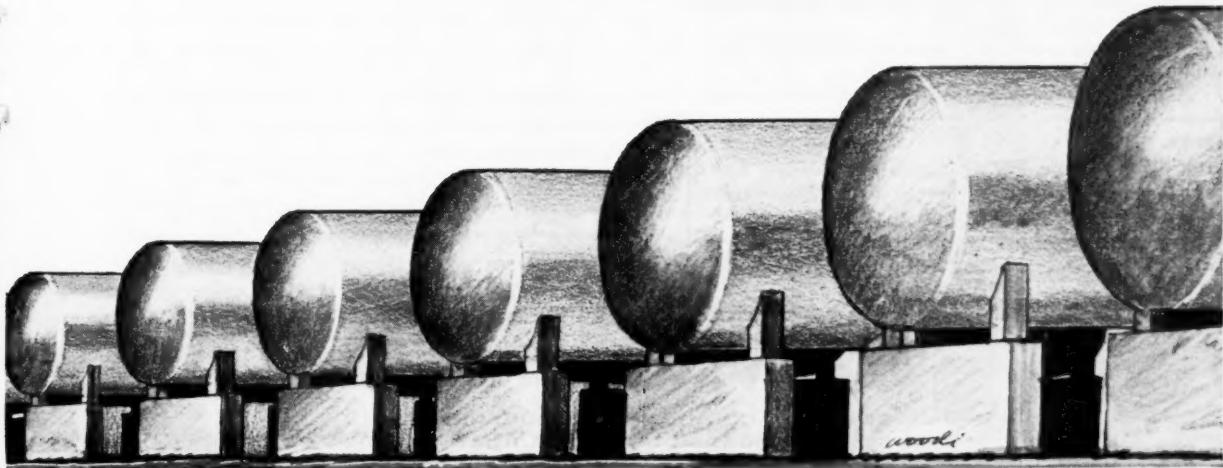
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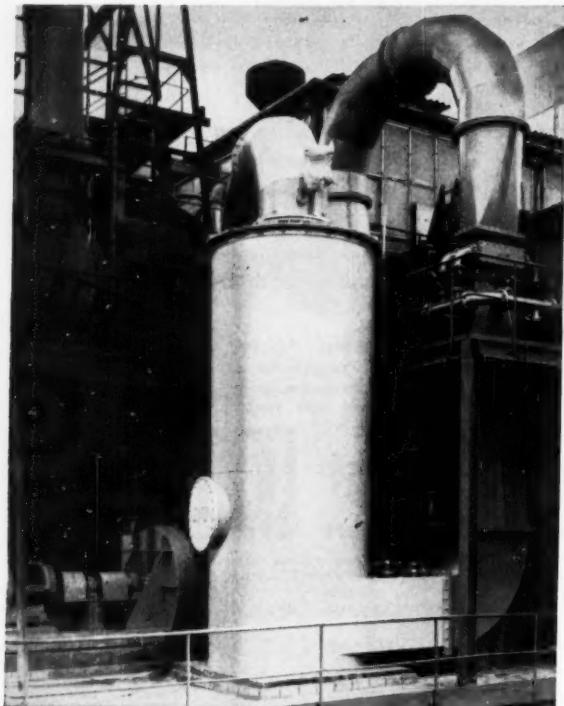
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AIR POLLUTION

growing problem in the chemical industry

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The Chemico venturi scrubber installed on this phosphoric acid plant removes and recovers better than 99% of the phosphoric acid mist. In this instance, both venturi and cyclonic separator are rubber-lined to withstand the effects of the acid.

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DOMESTIC DIVISIONS: AMERICAN PLATINUM & SILVER DIVISION, AMERSIL QUARTZ DIVISION, BAKER CONTACT DIVISION, BAKER DENTAL DIVISION, BAKER SETTING DIVISION, BAKER PLATINUM DIVISION, CHEMICAL DIVISION, EAST NEWARK INDUSTRIAL CENTER, HANOVIA LAMP DIVISION, HANOVIA LIQUID GOLD DIVISION, IRVINGTON-BAKER REFINING DIVISION, D. E. MAKEPEACE DIVISION, NATIONAL ELECTRIC INSTRUMENT DIVISION, RESEARCH AND DEVELOPMENT DIVISION, H. A. WILSON DIVISION. COMPANIES ABROAD: ENGELHARD INDUSTRIES OF CANADA, LTD., TORONTO, ENGELHARD INDUSTRIES OF QUEBEC, LTD., MONTREAL, ENGELHARD INDUSTRIES, LTD., LONDON, ENGELHARD INDUSTRIES A. G., ZURICH, ENGELHARD INDUSTRIES PTY., LTD., MELBOURNE, SOCIEDAD SURAMERICANA DE METALES PRECIOSOS S. A., BOGOTA, INDUSTRIE ENGELHARD S. P. A., ROME, ENGELHARD INDUSTRIES OF SOUTHERN AFRICA, LTD., JOHANNESBURG. ASSOCIATED COMPANIES: ACME TIMBER INDUSTRIES LTD., SOUTH AFRICAN FOREST INVESTMENTS LTD., SOUTH AFRICA, AZOPATE CORPORATION, CHARLES ENGELHARD, INC., NUCLEAR CORP. OF AMERICA, INC., U.S.A.



**platinum clad
sheet, tubing and wire
for low cost
corrosion-resistant equipment**

Platinum clad sheet tubing and wire make it possible to incorporate all the important corrosion resistant qualities of the noble metals in equipment, at minimum cost. Platinum clad is pure platinum or an alloy of platinum so securely bonded to a base metal body that the composite metal can be fabricated. The gauge of the platinum metal can be specified to requirements. The process guarantees continuous pin-hole-free platinum cladding to withstand high temperatures without oxidation.

BAKER PLATINUM DIVISION • 113 ASTOR STREET
NEWARK, N. J.

BAKER
PLATINUM
DIVISION

**Hanovia utility model
quartz lamp for preliminary
determination
of photochemical reactions**



The Hanovia Utility Model Lamp is a compact, powerful laboratory-size ultraviolet lamp of major value for preliminary determination of the potential benefits of photo-chemical reactions in your own processes. It provides a concentrated source of ultraviolet radiations in the far, middle and near regions of the ultraviolet spectrum. It is an excellent apparatus for fluorescence determinations by filtered ultraviolet (black light). This powerful lamp is also very satisfactory for the illumination of optical apertures, for microscopy, and absorption spectra studies. Other models are available for pilot plant operation and for commercial production.

HANOVIA LAMP DIVISION • 100 CHESTNUT STREET
NEWARK, N. J.



HANOVIA
LAMP
DIVISION

BRISTOL'S INSTRUMENTATION



News and information about automatic controlling.

Advanced developments from Bristol

SET NEW STANDARDS IN PNEUMATIC CONTROL INSTRUMENTATION

• assure dependable accurate control • easy servicing • convenience in use

New ideas at Bristol are revolutionizing some of the older concepts of pneumatic control instrumentation. These giant strides are making obsolete many designs that are only a few years old—but are already outmoded by modern Bristol equipment that gives better control of process variables and sets new standards for dependability.

Take, for example, the new Bristol Series 500 Wide-Band Pneumatic Controllers. These recent products of Bristol engineering and development are outstanding for stability of output on difficult process-control problems. They incorporate many advanced features, such as reset action stops and a true zero derivative setting, which are found on no other line of pneumatic controllers.

Best maintenance record

Basic simplicity, accurate design, closely held manufacturing tolerances make one single adjustment all that's necessary on the Bristol 500—even after complete disassembly and reassembly with replacement parts.

This practically "built-in" calibration is typical of the foresight and engineering planning that make the Series 500 the easiest pneumatic control system on the



market to service. Cut-and-dry methods are eliminated. No special maintenance skills are required. All parts are completely interchangeable. The result: a truly superlative maintenance record in thousands of industrial plants.

Famous Bristol measuring elements

The heart of an instrument, whether it be for recording, controlling, or telemetering, is its sensing and measuring system. That's why, for the 70 years of its existence, the Bristol Company has thrown its resources into the development of measuring systems.

Today, Bristol has longer, wider experience in this field than any other instrument company. Bristol leadership in measuring elements is recognized and respected the world over.

Bristol instruments come with the widest selection of high-quality measuring elements available for any line of instruments. Temperature, pressure, vacuum, draft, absolute pressure, liquid level, flow, humidity, density, pH, are just a few of the variables that can be measured—plus a large number of other variables measurable with air-controlling electronic potentiometers and bridges.

SEVERAL HUNDRED STANDARD MODELS MEET EVERY PROCESS REQUIREMENT INCLUDING:

These problems:

1. Cascaded control
2. Selective control
3. Ratio control
4. Time program control
5. Pneumatic transmission

These operating modes:

1. Fixed narrow band (on-off)
2. Proportional—to 100% and to 30%
3. Reset with wide band—to 400%
4. Derivative (rate)
5. Reset plus derivative

Bristol electronic control assures uniform ceramic tiles

Uniform size, color, texture and strength of ceramic tiles depend, among other things, on exact control of firing temperature. That's why Orange County Ceramic Tile Manufacturing Company, Huntington Beach, Cal., makers of the brilliant SUNSET tile line for home and industry, use Bristol Dynamaster® Electronic Pyrometers for accurate automatic control of kiln temperature. Precision automatic control insures an exceptionally uniform product and frees skilled production line supervisors from the need of constant checking.

*T.M. Reg. U.S. Pat. Off.



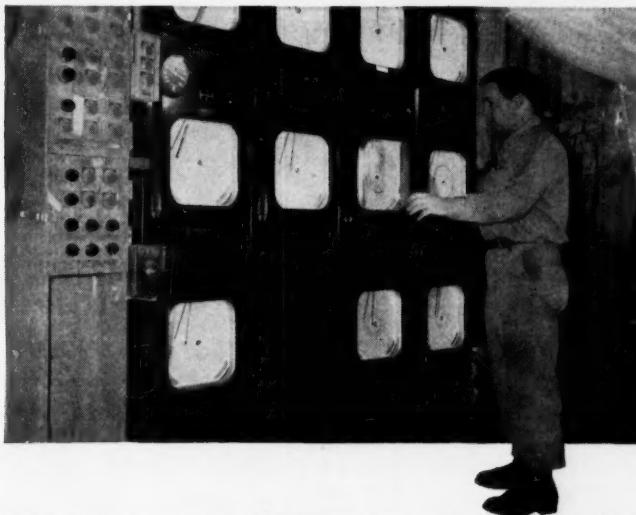
Electrical measurement with air control, electrical control, digital or analogue read out

Bristol Dynamaster® potentiometer and bridge instruments are the most widely versatile electronic instruments on the market today. Models are available not only for precision pyrometry with thermocouples, radiation pyrometers or resistance thermometers, but for measurement, recording and electrical or air control of pH, speed, voltage, current, power, resistance, strain-gauge output and many other variables. An extremely wide variety of attachments and accessories is available—including auxiliary transmitting devices, digital encoders, alarm contacts, etc. Round or Strip charts (see photos below). Most models available for standard 19" relay rack-mounting.



NEWS AND NOTES

recording and telemetering instruments from Bristol



INSTRUMENTS HELP EXTRACT STRATEGIC MANGANESE

These Bristol Series 500 recorders and recorder-controllers are keeping tabs on the exclusive manganese extraction process used by Manganese Chemical Company, Riverton, Minnesota, one of the few domestic producers of chemical manganese compounds. The Bristol air-control instruments monitor reducing gases, cooling gases, in-

dicate leach liquor liquid levels and record vital temperatures in the production process. The plant is in operation 24 hours a day, 7 days a week and the Bristol 500's stand up to this grueling service with the same outstandingly high reliability that they are showing in hundreds of other chemical plants throughout the world.

500's CONTROL OIL TEMPERATURE FOR STEEL ROLLING

These Bristol Series 500 instruments are two of a number used to control the temperature of lubricating oil supplied to the rolling mill main bearings on the number one rod mill at the Cuyahoga Works of U. S. Steel's American Steel & Wire Division.

The instruments maintain temperature of the lubricants at 100°F for the entire system by controlling the amount of cooling water being used.

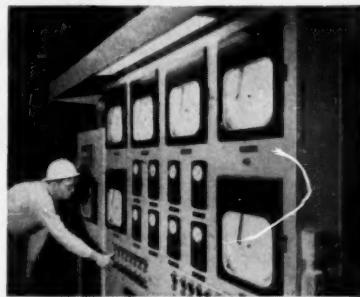
Bristol Series 500 instruments are noted for their excellent maintenance record under severe environmental conditions, can be maintained without special skills, special tools. What's more, Bristol service engineers, operating out of the main plant, four branch plants, and from 44 principal



cities, are available to help you apply series 500's (or any Bristol instruments) and assure you of their long, continuous, trouble-free service.

3 big reasons for air-control in this plant

Sometimes it's a toss up between air or electronic control. Not so in Lithium Corporation of America's Bessemer City, North Carolina, plant for extraction of lithium from low-grade ore. Three cogent reasons suggested air control for a large part of this operation: (1) positive pressure of 15 to 20 psi would protect the system from humidity, dust and corrosive fumes, (2) short transmission lines (none longer than 1100 ft., most only 200 to 300 ft.) would insure positive, lag-free operation and (3) cost of an air-control system for their \$7-million plant was estimated at only \$150,000 to \$200,000.



Have any doubts about what control system you should use? Get Bristol's absolutely unbiased recommendation: As makers of all types of electronic and pneumatic process control instruments, Bristol is in a unique position to help you get the instrumentation that's exactly right for your needs.

840

ASK FOR COMPLETE DATA

We'll be glad to send you complete technical information on any Bristol instrument. Or trained Bristol field engineers, familiar with the problems of your industry, will welcome the opportunity to discuss a complete, integrated system of measurement, recording or control—pneumatic or electronic—for your plant. Write The Bristol Company, 109 Bristol Road, Waterbury 20, Conn.

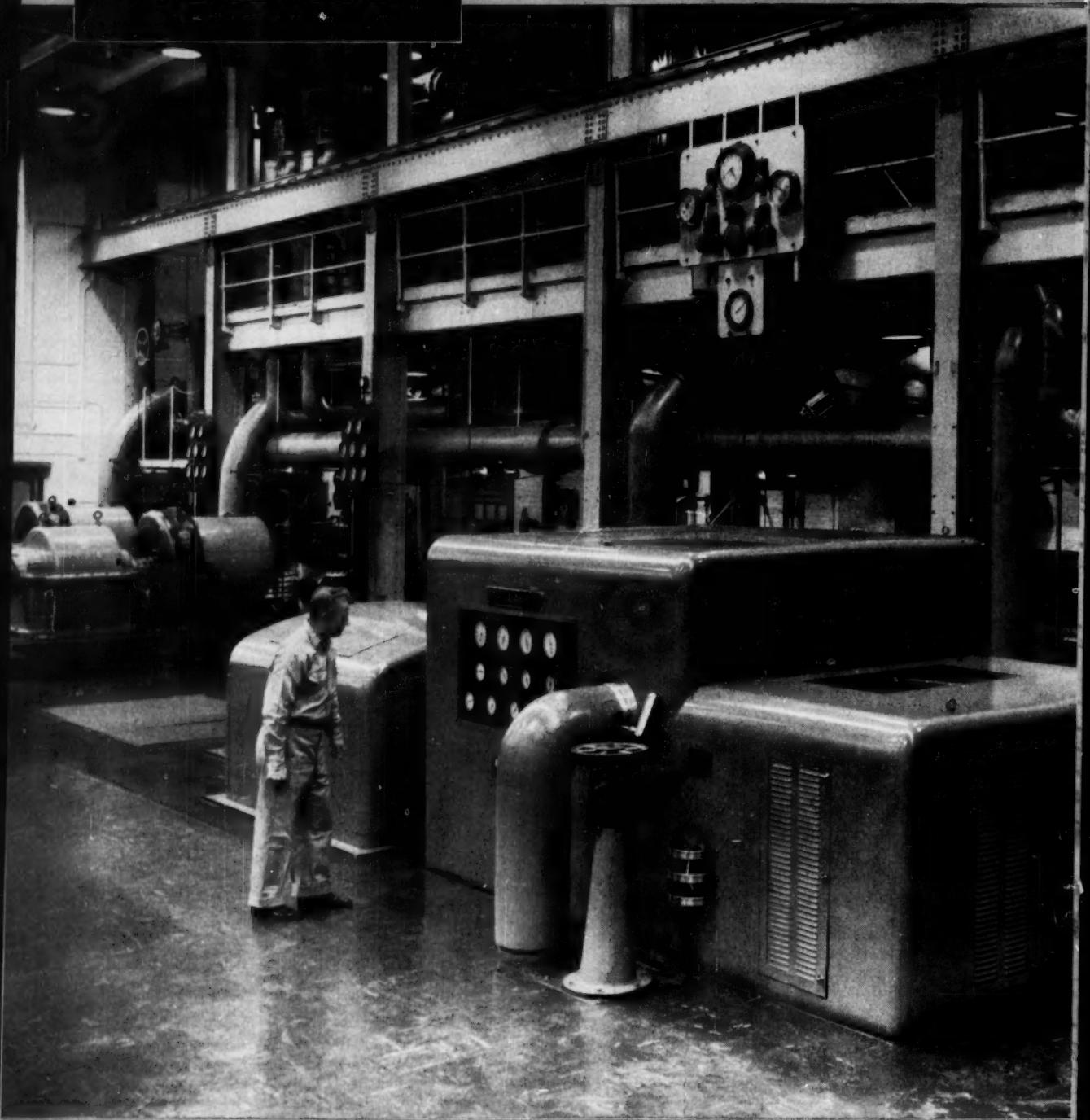
BRISTOL

TRAIL-BLAZERS IN PROCESS AUTOMATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETRY INSTRUMENTS

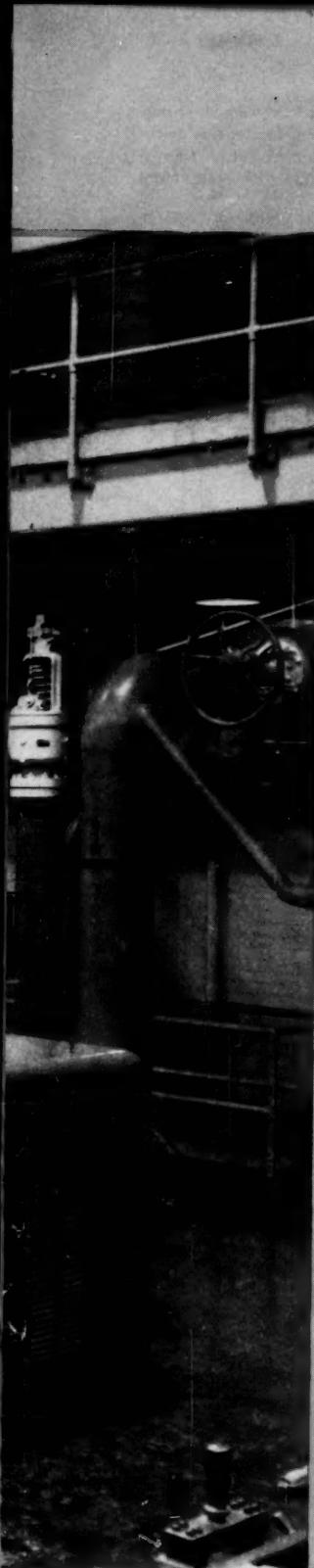
**DE LAVAL
STEAM
TURBINES**

for process industries



The photograph above shows a De Laval direct-connected turbine generator installation at Parke, Davis & Co., Detroit, Michigan.

This controlled extraction, controlled back-pressure unit supplies 5000 kw using process steam. Extraction is at 130 psig, exhaust is 5 psig. This new machine was added to already existing De Laval units that have been in service for 30 years. In addition, the Parke-Davis Research Laboratories in Ann Arbor, Michigan will soon be using a new 1000 kw unit.



Parke, Davis & Co.

uses

DE LAVAL Steam Turbines for process and power generation

Proved economy, dependable service

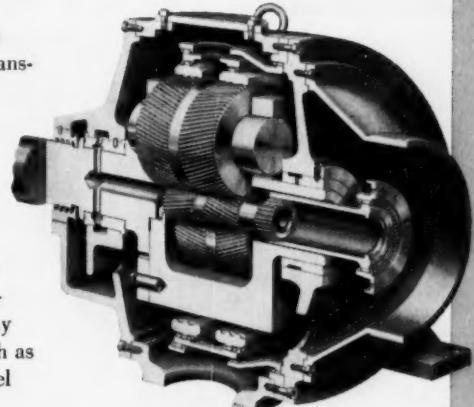
In many process industries, an important by-product is economical electric power. If appreciable quantities of process steam are used, power generation can be achieved at comparatively low cost.

De Laval, pioneer in high speed rotating machinery, has continued to maintain engineering and manufacturing leadership. If you have process application where low-cost power generation can be utilized, call on De Laval.

De Laval-Stoeckicht Planetary Gears

In many applications where high speed and high horsepower are transmitted, the De Laval-Stoeckicht planetary gear can be used to great advantage. It is also used as a speed increaser or decreaser in many industrial installations.

Among its outstanding characteristics are light weight, in-line construction and space saving. It may be used for all kinds of drives such as gas turbines, steam turbines, diesel engines, etc.

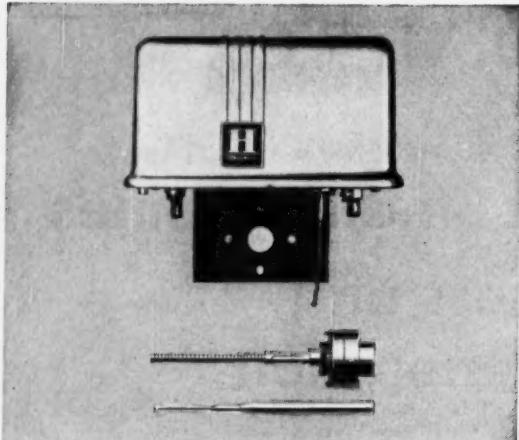


Write for Bulletin 2400

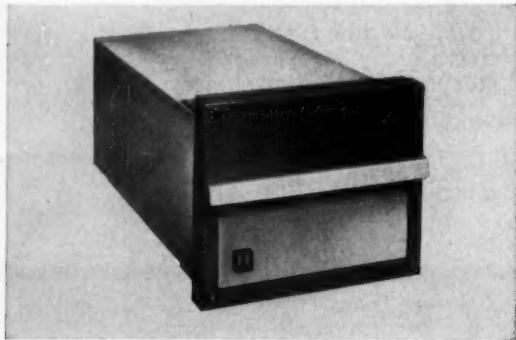


DE LAVAL Steam Turbine Company

503 NOTTINGHAM WAY, TRENTON 2, N. J.



TEMPERATURE OR PRESSURE TRANSMITTER unexcelled for versatility, converts quickly from temperature to pressure service. Equally accurate at small spans of 20 psi and 50 F or at wide spans of 150 psi and 400 F. Range fully adjustable without adding or changing parts.

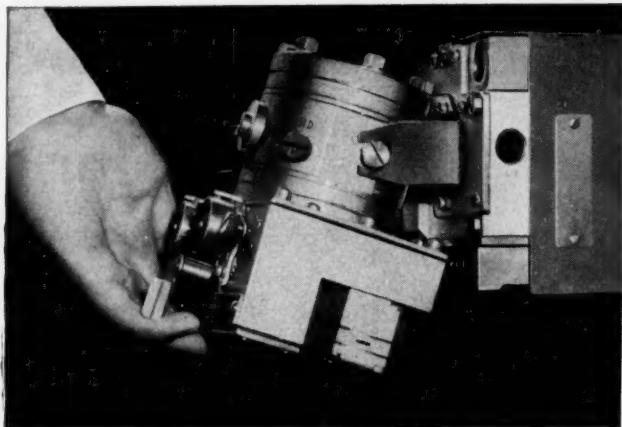


THERMOCOUPLE TEMPERATURE TRANSMITTER for temperature measurement, converts any thermocouple or other millivolt signal to a standard 3-15 psi pneumatic signal. Eliminates thermal systems.

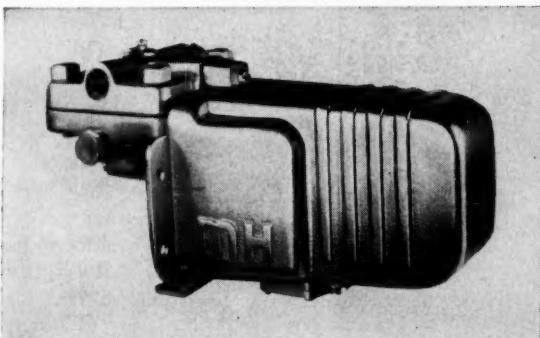


BELLOWS FLOW METER TRANSMITTER is unequalled for accuracy, stability and versatility. Convenience features include fast range changing in field, quick calibration and adjustment, easy cleaning and servicing.

TEL-O-SET CONTROLLER accepts signals from transmitter and is conveniently mounted on back of instrument case. Has quick-connect switch permitting both fast mounting and easy removal without upsetting process. It can be separately mounted in any remote location.

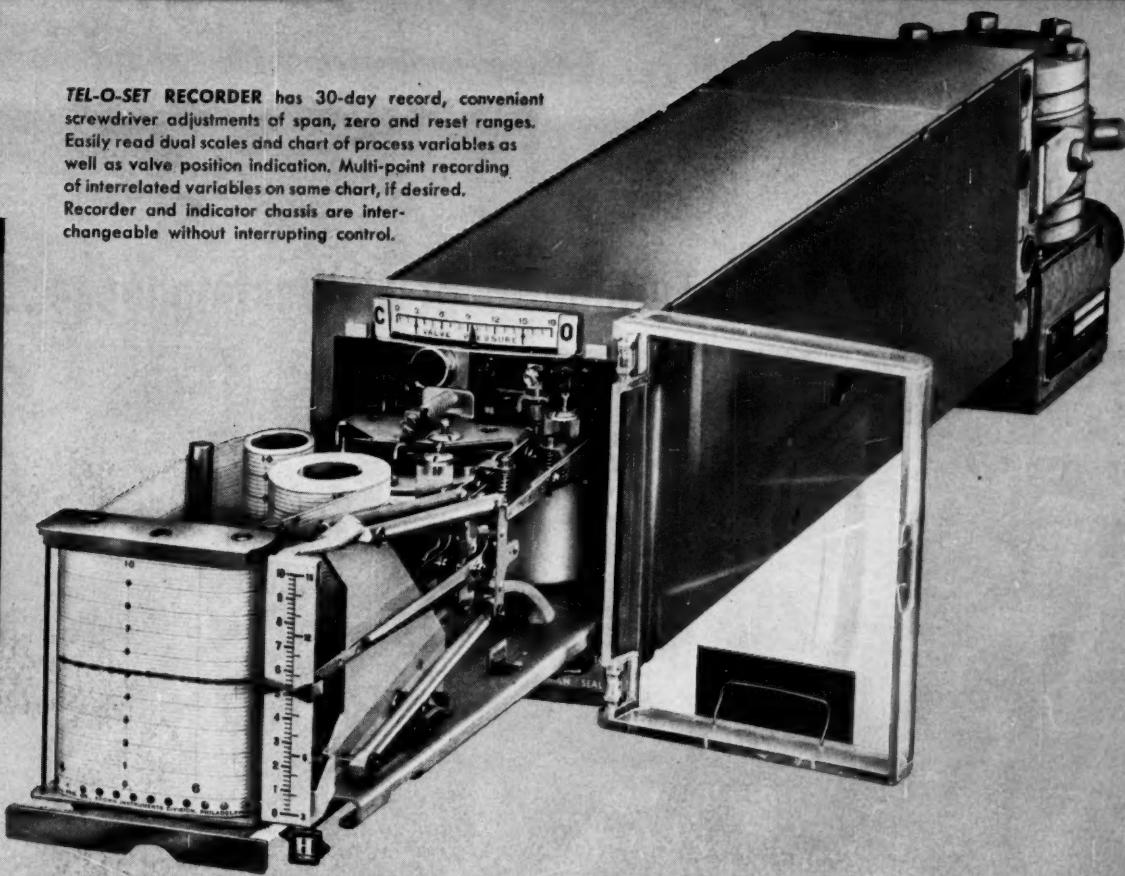


Control...
with advanced



DIFFERENTIAL CONVERTER FLOW TRANSMITTER offers many advantages where low volume displacement is desired. A fitting companion to the Bellows Meter. Designed for pressures up to 5000 psi. Mercuryless, it's accurate within $\pm \frac{1}{2}\%$ of full scale. Range continually adjustable in field.

TEL-O-SET RECORDER has 30-day record, convenient screwdriver adjustments of span, zero and reset ranges. Easily read dual scales and chart of process variables as well as valve position indication. Multi-point recording of interrelated variables on same chart, if desired. Recorder and indicator chassis are interchangeable without interrupting control.



every process variable . . .

TEL-O-SET miniature instruments

Simplify control of your process, and gain the extra savings that come with *Tel-O-Set* miniature pneumatic instruments. The same instrument can be used to record, indicate and control virtually any variable—temperature, pressure, flow, fuel-air ratio.

This interchangeability means important economy for you: Process operations can be changed without obsoleting your instruments. Personnel training time is minimized. Parts inventory is kept low.

Tel-O-Set instruments are accurate, sensitive, have true linear calibration, and respond swiftly to process changes. No miniature pneumatic instrument can match them for ease and economy of maintenance.

Get complete details from your nearby Honeywell field engineer. Call him today . . . he's as near as your phone.

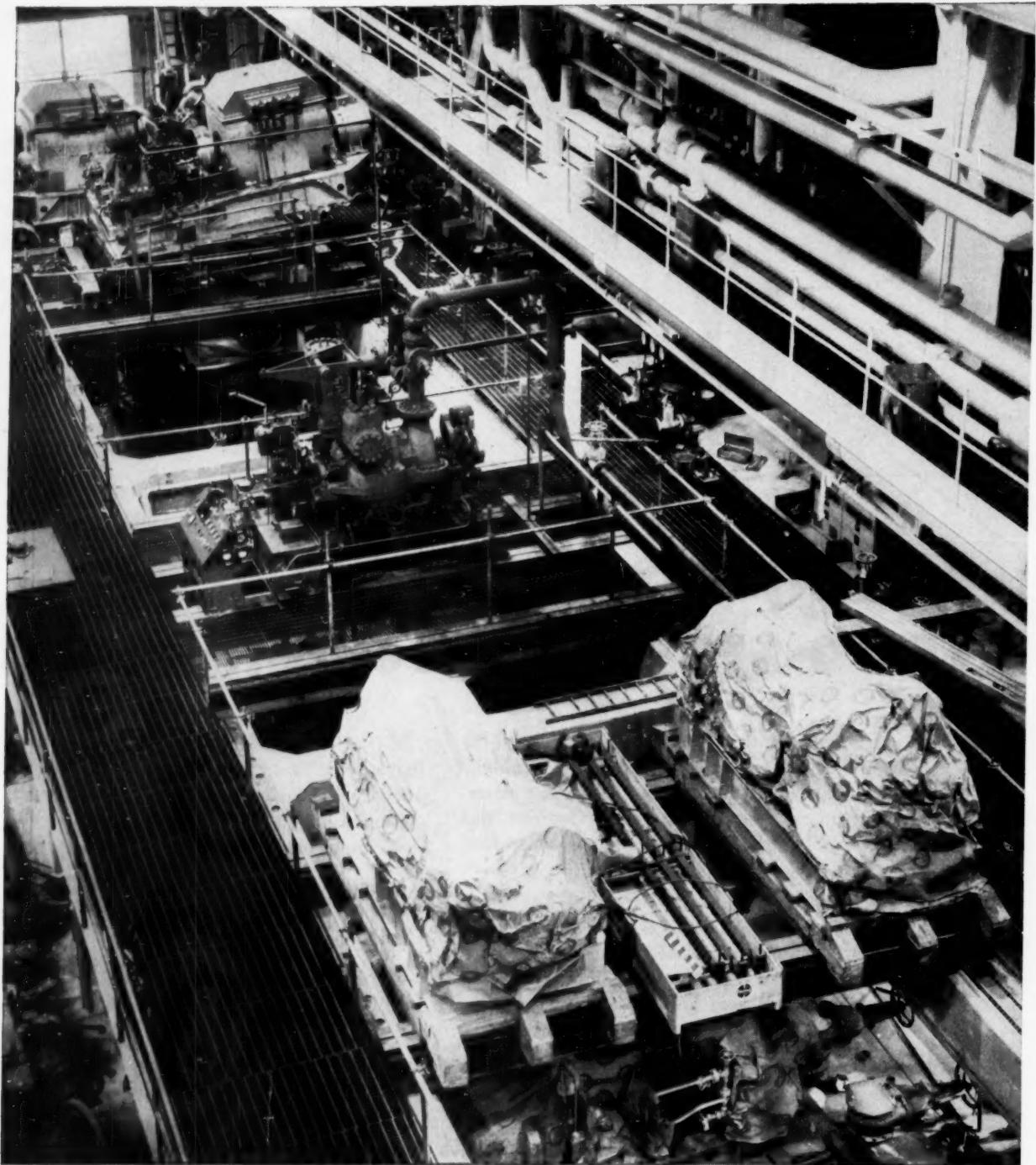
MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

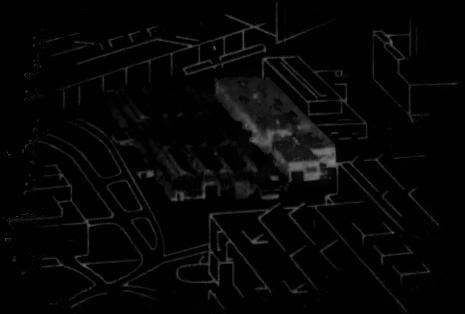


First in Control

New Small Turbine Plant at Westinghouse . . .



meets your exact power needs ... speeds deliveries



As part of the Westinghouse Steam Division, these completely self-contained small turbine facilities assure you of personal attention and service.

Left: Portion of the test facilities at new plant, showing (top to bottom) tilt test, boiler feed pump test and two units ready for shipment.

Here at the world's most modern small turbine facility, engineering, manufacturing and quality control are tailored to individual customer requirements.

Backed by extensive research and development, long-range planning and expansion of these facilities now bring you these major advantages . . .

*Exact power needs from the most complete product line in the industry** — Knowing that turbine users must consider both capacity needed and the economics of steam consumption, Westinghouse has developed the world's broadest line of small turbines.

Extensive quality control — Each turbine is thoroughly tested and proved before shipment to insure the highest efficiency and reliability. Checks are made at all critical stages of production by the most advanced testing equipment available.

Individual service and fast delivery — In these new small turbine facilities, entire production sections are devoted to single components, while new assembly aisle test stands offer the most advanced production techniques available for this type of manufacturing process.

While the specialized operations of the Small Turbine Department are completely self-contained to assure you of personal attention and service, the resources, facilities and experience of the entire Steam Division are available to insure technical precision in meeting your specifications.

Westinghouse small turbine representatives will be glad to discuss your needs with you at any time. Just call, write or wire your nearest Westinghouse Apparatus Sales Office or the Westinghouse Electric Corporation, Small Turbine Sales, Lester Branch Post Office, Philadelphia 13, Pa.

**Single-Stage Turbines — seven frame sizes available with horsepowers from 5 to 4000, speeds from 1000 to 12,500 rpm, for pumps, fans, compressors, blowers, paper machines and special Navy-designed pumps.*

Multi-Stage Turbines — five frame sizes available with speeds to 16,000 rpm and horsepowers to 50,000 for paper machine drives; power plant generation up to 5000 kw; high-speed special process compressor drives; boiler feed pump drives, operating under any heat balance cycle; turbine-generator units for shipboard service.

High-Speed Reduction Gears — twelve frames are available for most economical turbine speed selection in low-speed applications.

J-50602

YOU CAN BE SURE...IF IT'S

Westinghouse

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV MONDAYS

CYANAMID

Chemical Newsfront



FABRIC OF THE FUTURE may well be paper, if these hats of the future are any indication. Designed in paper and shown during the annual conventions of the paper industry, they use paper fabrics processed with MELOSTRENGTH® resin for durability in any weather. This melamine resin makes paper strong even when soaking wet. And advances in dyeing and printing make these treated paper fabrics resemble straw, silk or lace. Resistant to scuffing, moisture and acids, MELOSTRENGTH-treated paper finds use in seat covers, duck decoys, maps, freezer food wraps, towels, napkins, shipping bags—even clothes lines and sails.

(Industrial Chemicals Division)



GREATER SAFETY AND CONVENIENCE in dispensing sterile sutures in the operating room are achieved with a recent improvement in suture packaging. Double SURGILOPEN SP® envelopes, made of a flexible transparent plastic laminate, are replacing glass tubes, bulky glass jars and jar solutions. A dry, light, double envelope that may be stripped open delivers sterile sutures and eliminates the hazards of broken glass. A safer suture dispensing technique and greater economy are provided by this new suture package.

(Surgical Products Division)

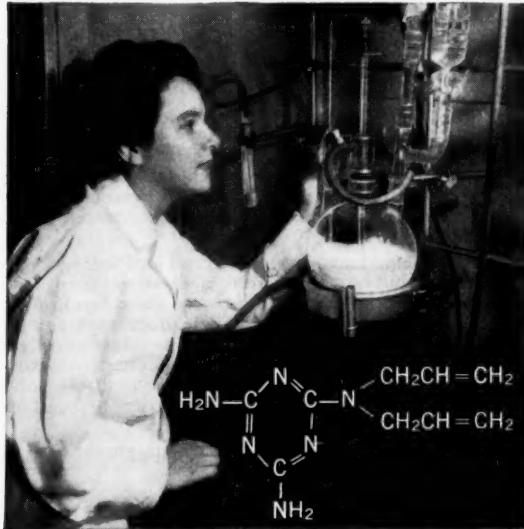
NEW SOURCE for urea of unusual quality is Cyanamid—*AERO*® crystalline urea. New paper chemicals, surface coatings, splicing and laminating adhesives and plastics have brought increasing demands for this versatile chemical. If you use urea, we would like you to know more about *AERO* crystalline urea, one of the purest grades commercially available. Write for technical information.

(Industrial Chemicals Division)



FAST COLORS IN LESS TIME mean economies for textile dyers using Cyanamid's CALCOFAST® Neutral Wool Dyes for wool, silk and nylon. Chemical and steam requirements are lower, adding to the labor savings of shorter dyeing time. The ten CALCOFAST Dyes now available offer a wide range of self shades and combination shades. More of these efficient dyes will become available as they move from research to plant production.

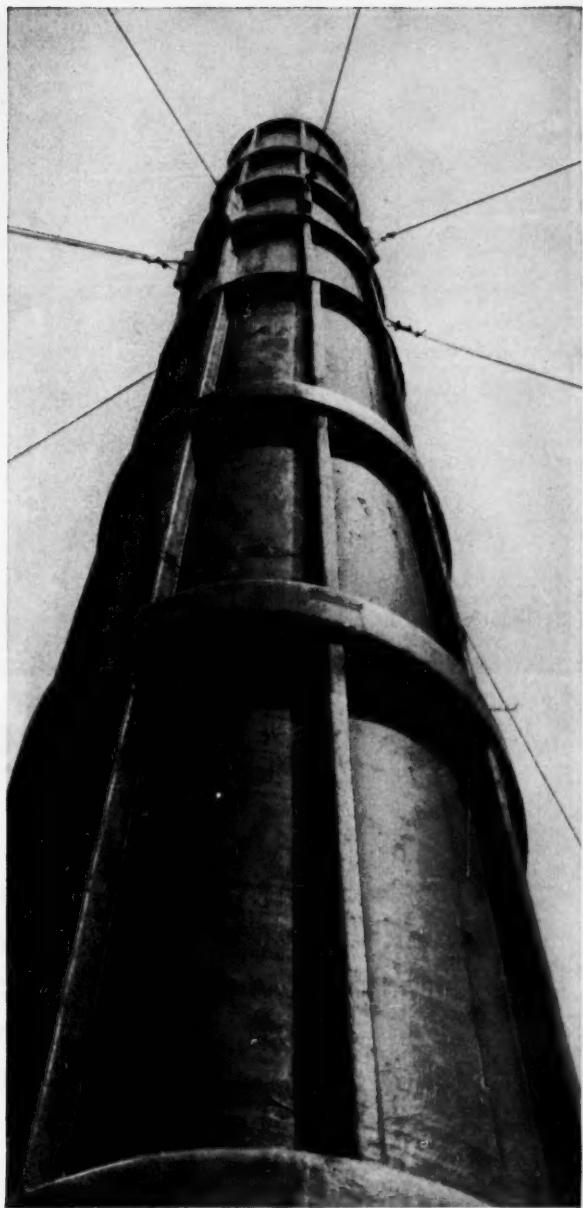
(Organic Chemicals Division)



NEW MULTIFUNCTIONAL CHEMICAL, *diallyl melamine*, offers many possibilities for preparation of plastics, ranging from clear molding compounds to laminating polymers. Diallyl melamine, one of many developed by Cyanamid's research laboratories, has both reactive double bonds and amino groups so that cross-linked and linear copolymers can be formed. If you have an interest in reactive monomers, send for technical information on this new polymerizable product.

(Market Development Department)

*Trademark



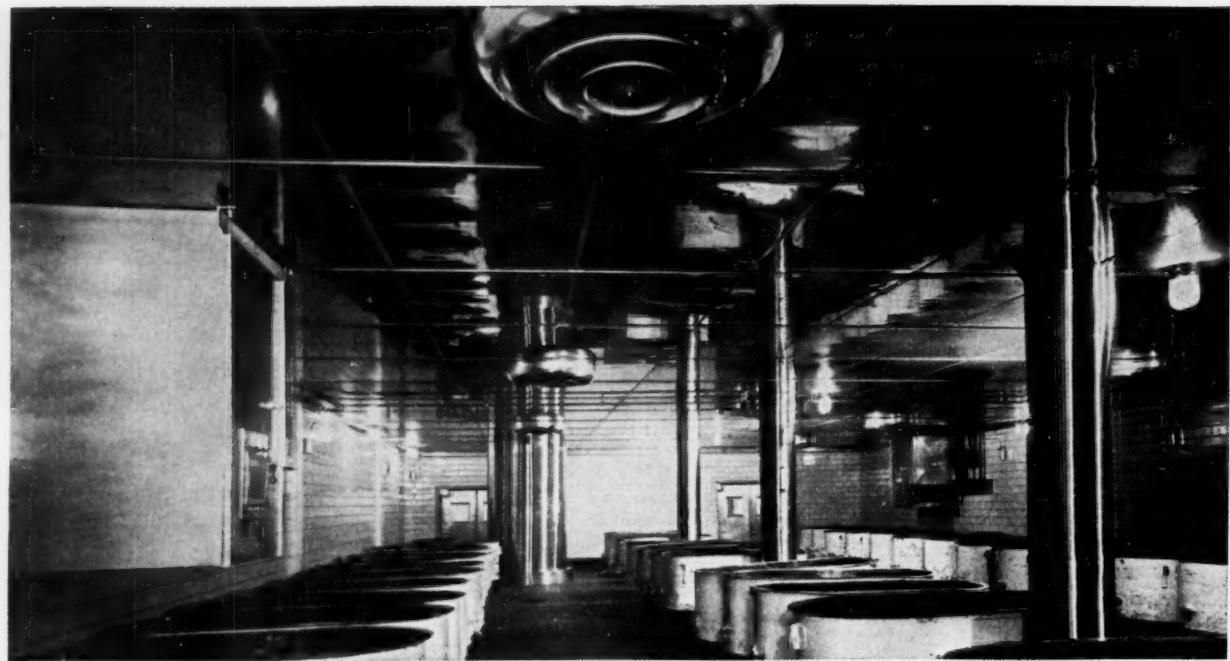
TOWERING PLASTIC STACK, fabricated entirely of reinforced LAMINAC® polyester resin, carries off highly corrosive gases such as hydrochloric acid and ammonia of chloride fumes. Made by Canbar Industrial Plastics of Canada, the stack is fabricated in three sections, stands 84 feet high. Unlike metal or brick stacks, the reinforced LAMINAC stack is highly resistant to corrosive attack and requires no maintenance. Lightweight, easily handled prefabricated components were installed in a few days.

(Plastics and Resins Division)



For further information on these and other chemicals, call, write or wire American Cyanamid Company

CHEMICAL ENGINEERING—April 20, 1959



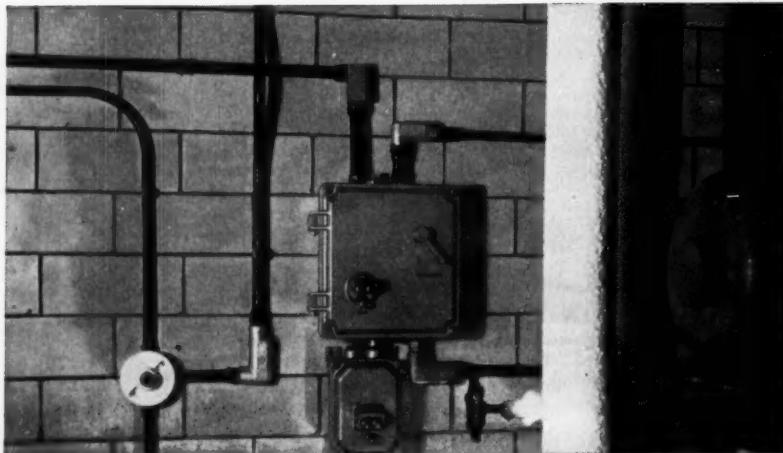
STAINLESS STEEL Pays for Itself in

Fermentation room fabricated from Republic ENDURO® Stainless Steel cuts maintenance costs, licks corrosion, assures uniform production and product.

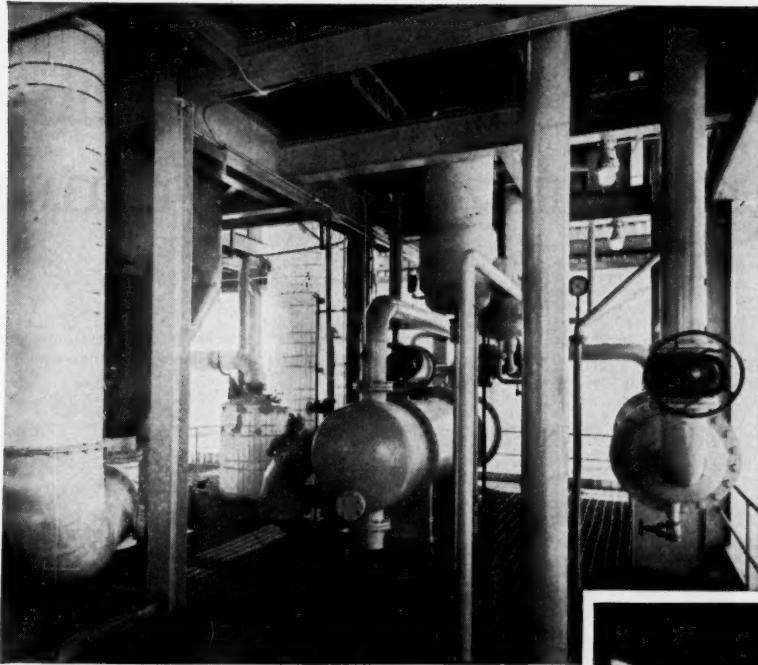
The fermentation room, shown above, is used in a cracker plant for maturing cracker sponges. Operating at 80°F. the year around and in 70-78% relative humidity, the room could present a costly problem in corrosion and corrosion-caused maintenance.

But the manufacturer, The Fred D. Pfening Company, Columbus, Ohio, designed around this problem with Republic ENDURO Stainless Steel, Type 302, for insulated ceiling panels, duct work and air conditioning equipment. This type offers excellent corrosion-resistance and is unaffected by atmospheric attack. And the fact that ENDURO is solid stainless steel means that there is no applied surface to crack, chip, flake or peel.

One major user of this type of equipment reports

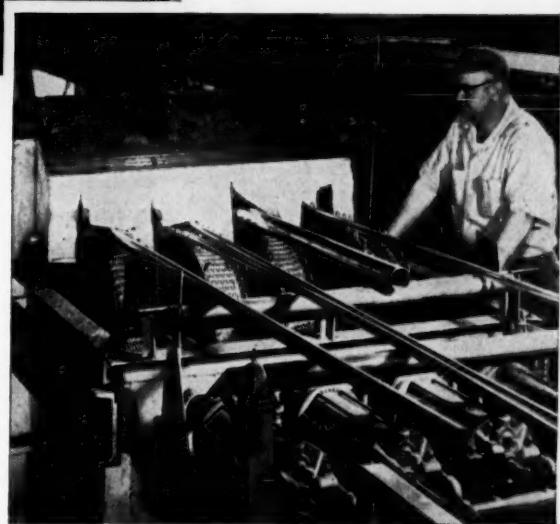


CONDUIT MAINTENANCE REDUCED TO A MINIMUM with Republic "Dekoron®-Coated" E.M.T. The corrosive action of vapors and moisture was causing rapid rusting of ordinary conduit in a cold storage plant. Replacement was frequent and costly. Then Dekoron-Coated Electrical Metallic Tubing was installed. In service for several years now, it looks as good as the day it was installed. A polyethylene coating over a galvanized finish provides double protection against excessive moisture, vapor and corrosive fumes. It can be cut to length and bent as easily as standard E.M.T. conduit. Joints are protected by plastic electrical tape. Also available in coated hot galvanized rigid steel conduit. Send coupon for details.



STAINLESS PAYS IN SOYA BEAN PROCESSING
at McMillan Feed Company. In the condenser, shown above, $\frac{3}{4}$ " O.D. Republic ELECTRUNITE® Stainless Steel Tubing meets the company's requirements for sanitation and corrosion-resistance. Stainless tubing eliminates the danger of metallic contamination. It is easy to clean and keep clean. Strong and durable, it saves time and money by giving maximum performance. ELECTRUNITE Stainless Tubing provides maximum resistance to temperature, pressure and physical damage. Send coupon for complete facts.

BRIGHT ANNEALED TUBING SAVES POLISHING COSTS. A new, continuous bright annealing furnace at Republic's Steel and Tube Division now makes it possible to obtain stainless tubing with a dense, lustrous finish—without paying high polishing costs. Tubing is produced with a hard, high-quality finish in sizes $\frac{1}{4}$ " through 4" O.D. Formed from Republic ENDURO Stainless Steel, every foot of tubing has uniform wall thickness, is perfectly concentric, meets all requirements of ASTM and ASME. Mail coupon for more information.



Maintenance Savings

that their cost records prove stainless steel pays for itself in maintenance savings alone in just six years. Compared to less versatile materials that require frequent painting and other protective coatings, stainless is an investment in reduced maintenance and long-range savings.

Shouldn't you be enjoying all the benefits of stainless steel in your processing operation? Republic field metallurgists are ready to work with you and your equipment-supplier in applying the many available ENDURO Stainless Steel analyses to best advantage. Just mail the coupon.

This example of the advantages of stainless steel is brought to you by Republic Steel in behalf of the stainless steel equipment manufacturers and the Republic Stainless Steel Distributors—your local steel service centers.

REPUBLIC STEEL

*World's Widest Range
of Standard Steels and
Steel Products*



REPUBLIC STEEL CORPORATION

DEPT. CE-5137-A

1441 REPUBLIC BUILDING • CLEVELAND 1, OHIO

- Have a stainless steel metallurgist call.
- Send more information on:
- ENDURO Stainless Steel
- Bright Annealed Tubing
- ELECTRUNITE Stainless Steel Tubing
- Dekoron-Coated E.M.T.

Name _____ Title _____

Company _____

Address _____

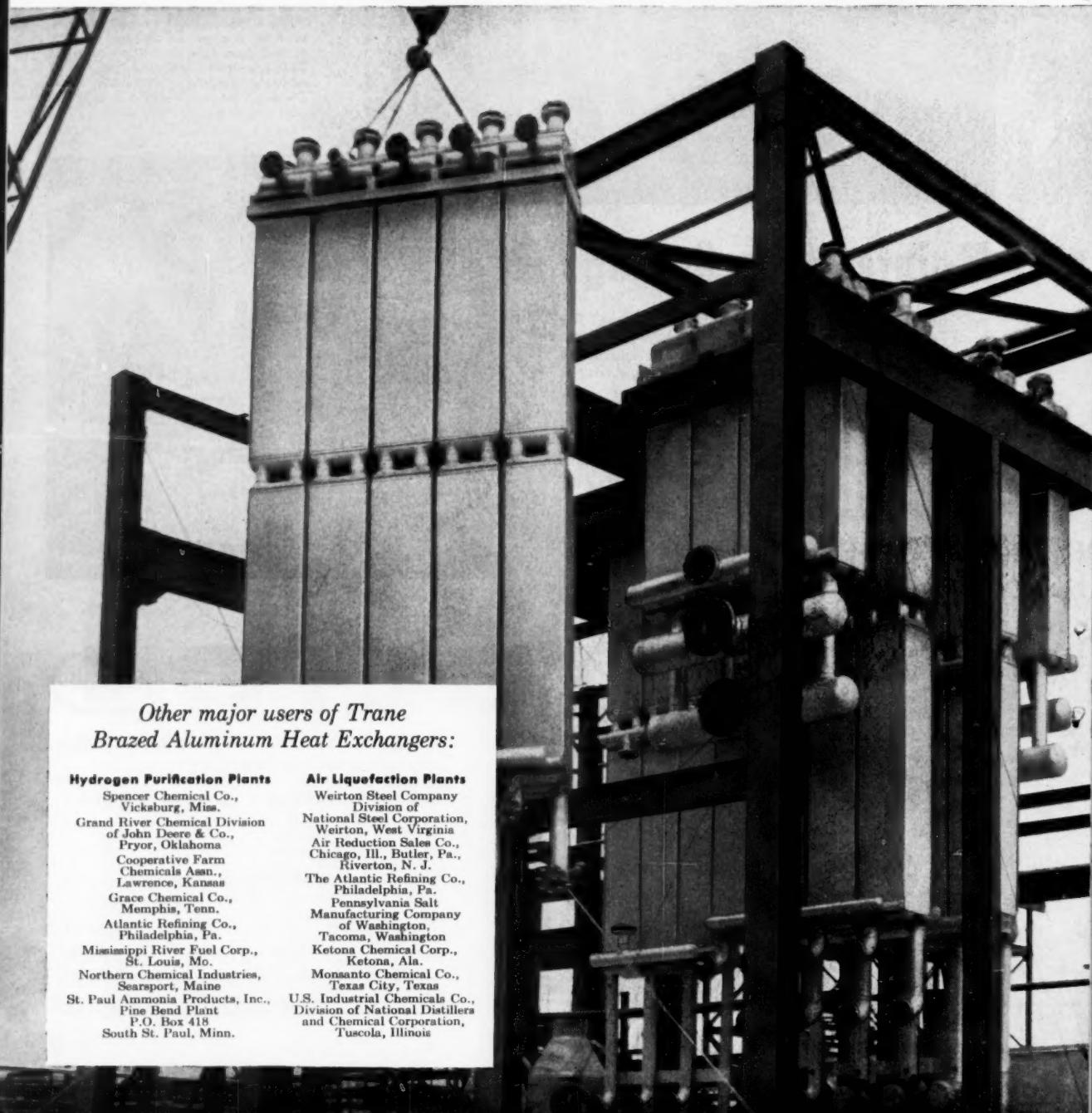
City _____ Zone _____ State _____

Rohm and Haas reports:

Close temperature approaches, Trane Brazed Aluminum

Sixty cores of TRANE Brazed Aluminum Heat Exchange surface are used in the production of oxygen at this Rohm and Haas plant. Installation was facilitated by the compact, rugged construction that cuts

space and construction costs . . . packs up to 500 sq. ft. of heat transfer surface into one cubic foot. These reversing exchangers were installed by AIR LIQUIDE.



Other major users of Trane Brazed Aluminum Heat Exchangers:

Hydrogen Purification Plants

Spencer Chemical Co.,
Vicksburg, Miss.
Grand River Chemical Division
of John Deere & Co.,
Pryor, Oklahoma
Cooperative Farm
Chemicals Assn.,
Lawrence, Kansas
Grace Chemical Co.,
Memphis, Tenn.
Atlantic Refining Co.,
Philadelphia, Pa.
Mississippi River Fuel Corp.,
St. Louis, Mo.
Northern Chemical Industries,
Searsport, Maine
St. Paul Ammonia Products, Inc.,
Pine Bend Plant
P.O. Box 418
South St. Paul, Minn.

Air Liquefaction Plants

Weirton Steel Company
Division of
National Steel Corporation,
Weirton, West Virginia
Air Reduction Sales Co.,
Chicago, Ill.; Butler, Pa.,
Hicksville, N. J.
The Atlantic Refining Co.,
Philadelphia, Pa.
Pennsylvania Salt
Manufacturing Company
of Washington,
Tacoma, Washington
Ketona Chemical Corp.,
Ketona, Ala.
Monsanto Chemical Co.,
Texas City, Texas
U.S. Industrial Chemicals Co.,
Division of National Distillers
and Chemical Corporation,
Tuscola, Illinois

high oxygen purity, using Heat Exchangers

*Lightweight, compact exchangers cut installation costs . . .
assure trouble-free operation . . . handle up to 6 fluids easily*

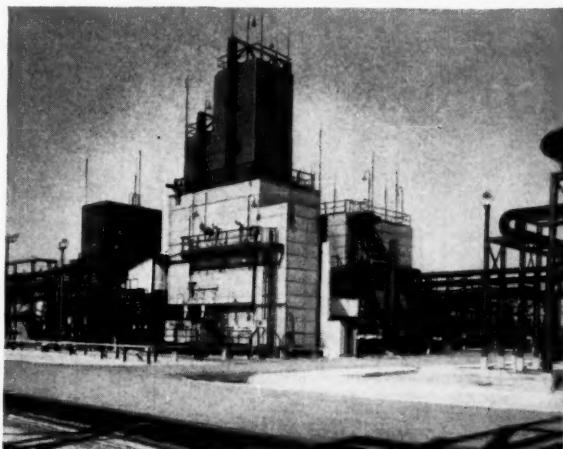
This Rohm and Haas plant in Pasadena, Texas, designed and constructed by AIR LIQUIDE, produces oxygen of high purity—well above specifications at the design rate—with TRANE Brazed Aluminum Heat Exchangers. After a full year of operation, Rohm and Haas reports temperature approaches as close as 2° F . . . operating temperatures as low as -291° F. And the plant started operation exactly on schedule—initial start up was accomplished within 12 hours.

This lightweight, compact heat exchange surface is being used in more and more installations where superior performance is essential—at over-all low cost. And TRANE

Brazed Aluminum Heat Exchangers reduce erection and space costs, too, because a typical TRANE cold box installation requires only *half as much space* as one using conventional heat transfer equipment!

So for reduced refrigeration costs, close temperature approaches and trouble-free operation, design with TRANE Brazed Aluminum Heat Exchangers! Thirty years of specialized heat transfer experience is at your service.

WANT MORE FACTS? Ask your nearby TRANE Sales Office for complete data and application histories. Or write TRANE, La Crosse, Wisconsin.



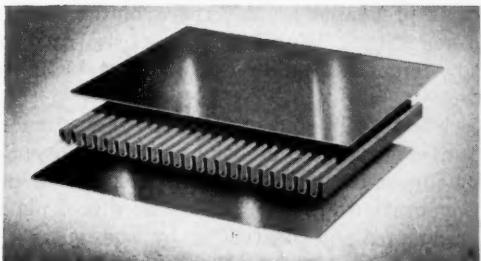
Over-all view of plant. TRANE Brazed Aluminum Heat Exchangers are used in the air plant, CO plant and in the nitrogen scrubbing unit. Plants are designed to operate down to -300° F. with pressures up to 450 psig. Installation in the CO plant features 6-stream operation. The oxygen plant is designed to produce over 300 tons per day.

For any air condition, turn to

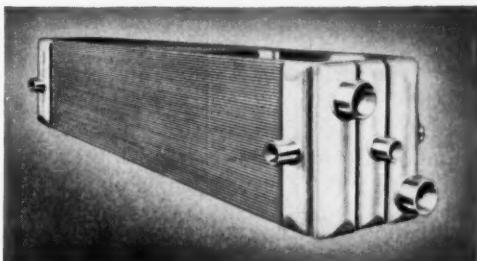
TRANE

MANUFACTURING ENGINEERS OF AIR CONDITIONING, HEATING,
VENTILATING AND HEAT TRANSFER EQUIPMENT

THE TRANE COMPANY, LA CROSSE, WIS. • SCRANTON MFG. DIV., SCRANTON, PA.
CLARKSVILLE, MFG. DIV., CLARKSVILLE, TENN. • TRANE COMPANY OF CANADA,
LIMITED, TORONTO • 100 U.S. AND 19 CANADIAN OFFICES



Lightweight, compact! TRANE Brazed Aluminum consists of corrugated aluminum sheets brazed together to form a stack of layers which provide individual passages for the flow of liquids or gases. Provides up to *nine times* the surface per square foot of shell-and-tube exchangers!



Headered for 5-stream operation, this TRANE Brazed Aluminum Heat Exchanger can handle as many as five fluids simultaneously. Units are available for either cross-flow or counter-flow operation. Surface can be fabricated in a wide variety of shapes and sizes to meet all types of requirements.

Visit Us at the Fifth World Petroleum Congress
Booth 686—June 1-5 New York, N. Y.



ENGINEERS AND CONSTRUCTORS FOR INDUSTRY

NEW ETHYLENE PROCESS DEVELOPED BY LUMMUS PROVIDES HIGH EFFICIENCY, UNUSUAL FEED-STOCK FLEXIBILITY

200,000,000 Lb/Year Plant for Petroleum Chemicals, Inc. Produces 99.7% Ethylene

The new Petroleum Chemicals, Inc. ethylene plant, now on stream at Lake Charles, Louisiana, incorporates a unique ethylene separation process developed by Lummus which provides high separation efficiencies and unusual flexibility and reliability (See flowsheet).

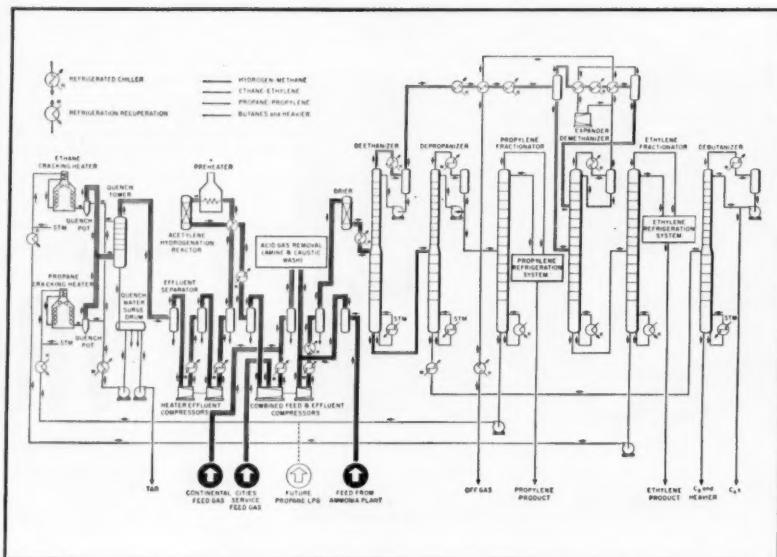
Lummus has designed the plant for rapid 50% expansion to a rate of 300,000,000 lbs./year. Ethylene is produced in two grades — the highest, 99.7%; the other, 98%. Co-products are high purity propylene, a butane-butylene fraction and aromatic distillate. Operations have been marked by continuous production of specification ethylene under widely varying rates and feed stock compositions.

Feed Gases From Three Sources

Feed gases for the P.C.I. plant are provided from three different sources: the nearby refineries of Cities Service and Continental Oil—by whom P.C.I. is jointly owned—and P.C.I.'s new ammonia plant.

High Efficiency Expanders

All major compressors in the Lummus-designed low temperature fractionation unit are driven by three 12,500 HP gas turbines. Gas turbine exhaust



serves as preheated air for three high pressure steam generators. High efficiency expanders provide low temperatures for maximum ethylene recovery.

Ethylene is delivered via pipeline to customers at Orange, Texas. In addition, part of the new plant's output feeds the adjacent Calcasieu Chemical Corporation ethylene oxide and glycol plant, also engineered and constructed by Lummus.

This plant brings the total of Lummus-designed ethylene plants to 13, with a combined capacity of over 1 billion pounds per year: (contd. next page)

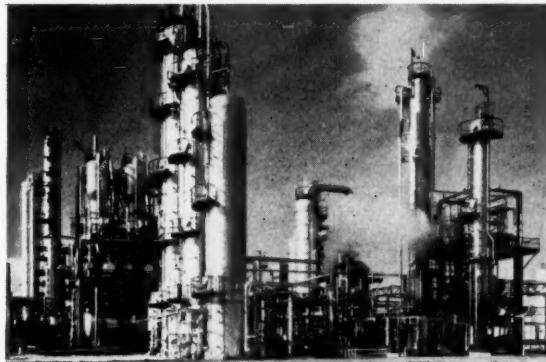
CUSTOMER

CUSTOMER	LOCATION
Monsanto Chemical Co.	Texas City, Texas, U.S.A.
Jefferson Chemical Co.	Port Neches, Texas, U.S.A.
E.I. du Pont de Nemours & Co.	Orange, Texas, U.S.A.
Texas Eastman Co.	Longview, Texas, U.S.A.
Gulf Oil Corp.	Port Arthur, Texas, U.S.A.
Societe Naphtachimie S.A.	L'Avera, France
Allied Chemicals Corp.	Tonawanda, New York, U.S.A.
National Petrochemicals Corp.	Tuscola, Illinois, U.S.A.
Canadian Industries, Ltd. (2 plants)	Edmonton, Alberta, Canada
Polymer Corporation Ltd.	Sarnia, Ontario, Canada
Societe Edison	Mantova, Italy
Petroleum Chemicals, Inc.	Lake Charles, La., U.S.A.

New Ethylene Oxide-Glycol Plant is third Shell process unit engineered and built by Lummus

Calcasieu Chemical Corporation's new ethylene oxide-glycol plant at Lake Charles, Louisiana is on stream and producing 8,000,000 gallons annually of ethylene glycol or 57,000,000 pounds of ethylene oxide.

Designed and engineered by The Lummus Com-



Over a half-century of Process-Industry experience

Here is just a partial list of chemicals for which Lummus has designed, engineered or constructed plants:

Acetone	Dichlorethane	Nitric Acid
Acrolein	Dichlorobenzene	Phenol
Allethrin	Di-isobutyl alcohol	Phthalic anhydride
Ammonia	Ethybenzene	Polyvinyl alcohol
Ammonium Nitrate	Ethyl Chloride	Polyvinyl Pyrrolidone
Ammonium Sulfate	Ethylene	Propargyl Alcohol
Benzol	Ethylene glycol	Propylene
Beryllium metal	Ethylene oxide	Pyrrolidone
Bisphenol	Epon® resin	Styrene
Butadiene	Formaldehyde	Sulfuric acid
Butanediol	Heavy Water	Surfactants
Butyndiol	Hydrogen	Tetramer
Butynediol	Hydrogen Sulfide	Trichlorethylene
Butyrolactone	Isopropyl alcohol	Trichlorobenzene
Carbon black	Lamp black	Toluene
Caustic soda	Magnesium sulfate	Uranium Oxide
Chlorobenzene	Mercuric nitrate	Vinyl acetate
Cumene	Naphthalene	Vinyl Pyrrolidone
Di-ammonium phosphate		

Discuss your next chemical or petrochemical project with a Lummus representative.

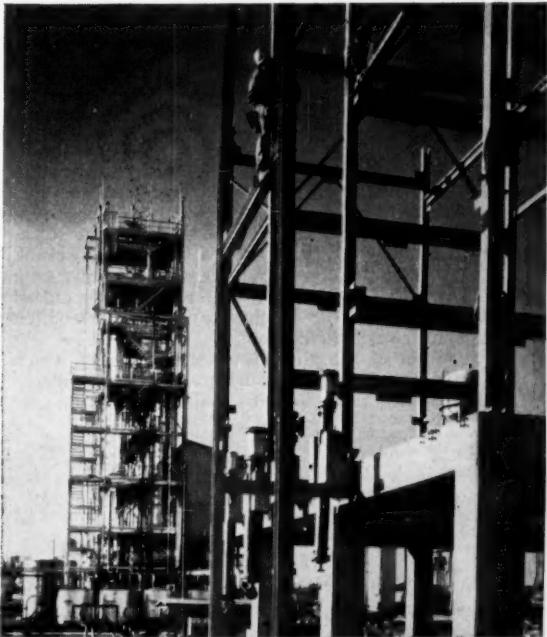
THE LUMMUS COMPANY, 385 Madison Avenue, New York 17, N.Y., Houston, Washington, D.C., Montreal, London, Paris, The Hague, Maracaibo. Engineering Development Center: Newark, N.J.

pany, the plant utilizes the two-step Shell Development Company Process, which offers the advantages of unusually high yields and virtual elimination of the waste-disposal problems encountered in the Chlorohydrin Process. The first step is direct catalytic oxidation of ethylene with oxygen in fixed bed reactors. Here ethylene oxide, valuable petrochemical intermediate, is produced for use by manufacturers of detergents and other surface active agents, plasticizers, solvents, textiles, drugs and many other petrochemical compounds.

The second step of the Shell Process calls for thermal hydration of ethylene oxide to ethylene glycol, essential to manufacturers of antifreeze, explosives, plasticizers, fibers, resins, hydraulic fluids and many more chemical products.

Article tells when to contract for pilot plant work, when to 'do it yourself'

Reprints are available now of a four-page article which discusses factors to consider in deciding when to engage an outside firm to do pilot plant work and when to "do it yourself." The article includes a comparative analysis of costs on a specific project: (a) as actually completed by Lummus for a client and (b) if the client had undertaken the program himself. For copies, write Lummus.



MORE POLYVINYL ALCOHOL RESIN — 20 million pounds per year will come from Air Reduction's new installation in Calvert City, Kentucky, now being engineered and built by Lummus. Shown above are Airco's original vinyl acetate monomer plant and the beginning of the new monomer plant which will double vinyl acetate output. The twin monomer plants will be the core of the huge polyvinyl alcohol resin operation, scheduled to come on stream early next year.

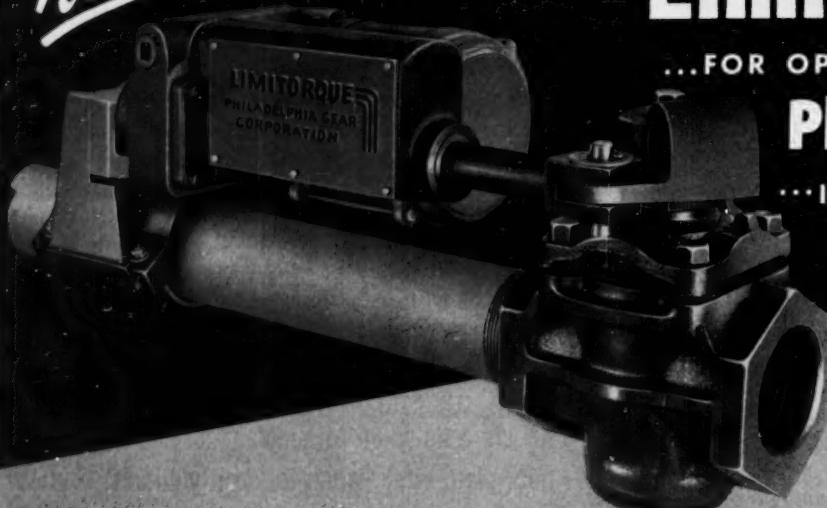
Visit the Lummus Exhibit, Fifth World Petroleum Congress Exposition, New York Coliseum, June 1-5, 1959

New AN AUTOMATIC, COMPACT **LimiTorque**

...FOR OPERATING YOUR

Plug Valves

...IN 8 TO 16 SECONDS



LimiTorque LINEAR MOTORIZED VALVE OPERATOR ...a dependable time, labor and money saver

Another LimiTorque *first* — here's the answer to the problem of motorizing your wrench (hand) operated Plug Valves . . . a simple, easily installed unit that can be built either to NEMA IV (weather-proof), or NEMA VII (explosion-proof) standards . . . an inexpensive, sturdy, fully reliable and extremely compact assembly that requires no gear changes or modifications, other than to supply a motor with the proper output speed. The *LimiTorque Linear Operator* consists of motor and double reduction gearing which drive a traveling screw and a crank that is easily mounted to the square shank of plug valve.

As noted in the illustrations, the entire assembly can be readily adapted to your plug valve while in service, by merely mounting the crank on the plug shank and strapping the support bracket to the pipe . . . The *Linear Operator* is supplied with all necessary adapting parts such as the support bracket and straps for mounting on the pipeline; also the necessary crank arm for mounting on the square shank of valve plug — The entire construction and operation is indeed simple . . . and the purchase price and installation costs are comparatively low.

A torque of 175# is developed at the valve, which is normally more than enough to drive most wrench-operated plug valves up to 6" in size. If power fails, or

manual operation is desired, the mere removal of a pin (which connects the traveling screw to the crank arm) will divorce the crank from the *Linear Operator* assembly — and a bar placed in the bushed bore of the crank arm will operate the valve. (No special wrench is needed.) The mere flick of a switch to the direction of travel desired will operate the valve . . . Contact your valve manufacturer, or your nearest LimiTorque Sales Engineering Office.

Full details on this new *LimiTorque Linear Operator* are contained in Bulletin 20-58 . . . send for copy on your business letterhead.

THERE IS NO SUBSTITUTE FOR —
LimiTorque®

PHILADELPHIA GEAR CORPORATION

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INDUSTRIAL GEARS & SPEED REDUCERS

LIMITORQUE VALVE CONTROLS

FLUID AGITATORS • FLEXIBLE COUPLINGS

LimiTorque Corporation • Philadelphia



U.S.I. CHEMICAL NEWS

Apr.

A Series for Chemists and Executives of the Solvents and Chemical Consuming Industries

1959

Soluble Sodium Complexes Prove Valuable for Wurtz Reactions and Metalations

It has been found that some aromatic hydrocarbons will form highly reactive soluble complexes with sodium in certain "active" ethers. These complexes are very useful for carrying out many metalation reactions and condensations of alkyl and aryl halides (Wurtz reactions).

Among the hydrocarbons found useful are naphthalene, diphenyl, the terphenyls and anthracene. The "active" ethers include dimethyl ether, methyl ethyl ether, dimethyl ether of ethylene glycol and tetrahydrofuran.

By proper choice of hydro-

MORE

Armed Forces Outline Still-Unsolved Chemical Problems; Call for Help

The National Inventors Council recently published a report titled "Inventions Wanted by the Armed Forces," discussing military needs for certain types of materials which cannot as yet be supplied for technological reasons. The report calls for the chemist's assistance in providing:

(1) waterproofing compound for gages that will be flexible from -20 to 140°F and bond to anything.

(2) metal-to-metal adhesive, good up to 600°F, with a shear strength of 2,500 psi minimum.

(3) adhesive for explosives which can be applied down to -40°F; hold a 2½-lb. block of explosive on a vertical square for 60 days, using about 15 sq. in. of block surface; support the block on a variety of dirty, wet or uneven vertical surfaces.

(4) easy method for growing large, single silicon crystals of uniform lifetime, resistivity and dislocation density.

(5) quartz crystal units in the 1-100 mc range, able to operate from -55 to 90°C without more than 5 ppm deviation from nominal frequency.

(6) method of making colored smokes which would reduce the present 80-90% dye loss due to decomposition.

Copies of the report can be obtained at no charge from the National Inventors Council, U. S. Dept. of Commerce, Washington 25, D.C.

New Process for HCl Said to Yield Economies

A preliminary German patent, DAS 1,035,626, claims that hydrochloric acid can be made very economically in a plant consisting of a single tower lined with graphite-based, corrosion-resistant material.

As described, the process consists of burning hydrogen and chlorine in a bell-shaped reaction chamber at the bottom of the tower. The resulting acid, as a gas, passes through slits in the chamber and travels up through an absorbent, noncorrosive packing. Water or dilute acid drips down, cooling the tower walls and the reaction chamber, and is concentrated at the same time.

Ethylene Is Basic Raw Material For Giant Chemical Complex

U.S.I. Uses Versatile Chemical 6 Ways: to Make Alcohol, Polyethylene, Ethyl Chloride, Ether; for Refrigeration In Its Own Manufacture; for Sale in Cylinders.

Ethylene is probably the most valuable petrochemical building block available to the CPI today. Almost four billion pounds were produced and used in 1957, and it is estimated that production capacity last year was about five billion pounds. At Tuscola, Ill., a huge complex of chemical plants — turning out a wide variety of large-volume products — has been erected on the foundation of a plentiful ethylene supply. Here, several natural gas pipelines from the Southwest join at a compressor station which feeds extraction and fractionation facilities. The ethane fraction from these facilities, converted to ethylene, becomes the "jack-of-all-trades" at the Tuscola complex.

The values of ethylene are its low cost and its ability to polymerize or react by addition with simple and inexpensive materials, such as hydrochloric acid, oxygen and chlorine, to yield extremely useful intermediates or end products. At Tuscola, ethylene is used for synthesis of polyethylene, ethyl alcohol, ethyl ether and ethyl chloride. A small portion is employed in the ethylene purification plant for refrigeration. It is also bottled under pressure in steel cylinders and sold as a ripening and conditioning agent for fruits and vegetables, as a chemical raw material, and as a refrigerant. (A new technical data sheet gives commercial specifications for U.S.I. refined ethylene, properties of the pure compound, and use data. Copies can be obtained upon request on company letterhead.)

100 Million Pounds of Polyethylene

Of the 500 tons of ethylene produced at Tuscola each day, a third is polymerized to polyethylene. Ethylene raw material for this process is brought to a very high purity in a separate step which employs the ethylene gas itself as a refrigerant. Converting ethylene to polyethylene requires two steps. The gas is compressed under extremely high pressure and pumped into the polymerization reactor, where it is held at high pressure and moderately high temperatures. A catalyst is added to start

the reaction. The polyethylene formed flows to a separation system where unreacted gas is removed. Low and intermediate density resins are produced by this process at Tuscola's 100-million-pound-per-year polyethylene plant.

Ethanol, Ether and Ethyl Chloride

Recycled ethylene, as well as fresh make-up from the ethylene unit, feeds into the ethyl alcohol facility where it is absorbed in sulfuric acid and then hydrolyzed under controlled con-



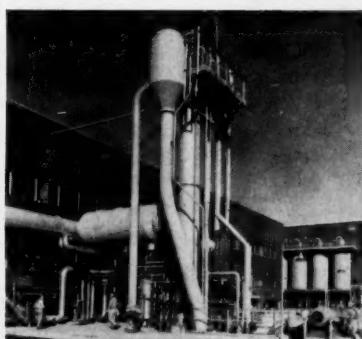
Ethylene in cylinders is sold by U.S.I. for food processing, as a refrigerant, and as a chemical raw material.

ditions to yield 190-proof and anhydrous alcohol. This synthetic alcohol plant is among the country's largest and supplies alcohol raw material for a large segment of the American chemical industry. Ethyl ether is a by-product of the same process. In another plant, by reaction with hydrochloric acid, more ethylene is converted into ethyl chloride — sold for production of tetraethyl lead and other products.

Advantages of Integrated Production

The Tuscola operation could, if the demand arose, produce other ethylene derivatives such as ethylene oxide, ethylene dichloride and ethylene chlorohydrin. The integrated plant permits great economies in the production of all derivatives. Ethylene not used in making other U.S.I. products is sold in cylinders.

Over the last few years, as the market for polyethylene has soared, ethylene production capacity at Tuscola has been doubled. If activity within this integrated chemical complex is any indication, the demand for ethylene as a chemical building block should certainly reach and exceed the 6.5-billion-pound mark now being predicted for 1965.



U.S.I. ethylene unit supplies 100-million lb.-per-year polyethylene plant at Tuscola, Ill.

Apr.

1959

U.S.I. CHEMICAL NEWS

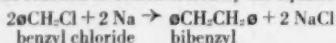
CONTINUED

Sodium

carbon and active ether, reaction conditions may be so chosen that no interference from the solubilizing components will be noted. The rate of formation of these soluble sodium carriers is much more rapid and complete with sodium dispersions than with massive sodium. Sometimes dispersions are made directly in these aromatic hydrocarbons.

A soluble complex will transfer sodium from the carrier to another organic compound with the regeneration of the hydrocarbon carrier. The hydrocarbon then promptly solubilizes additional sodium. Thus only a catalytic amount of hydrocarbon is required.

As an example of this very useful technique, bibenzyl in dimethyl ether can be prepared from benzyl chloride using a sodium dispersion solubilized in naphthalene and terphenyl. The reaction is demonstrated by the equation:



Details of this preparation are given in U.S.I.'s brochure "Sodium Dispersions," available on request.

Another interesting application of sodium complexes is the use of sodium and naphthalene for etching "Teflon" resin surfaces so that the "Teflon" resin can be bonded to other materials.

Experimental Fuel Cell Converts Chemical Energy Directly to Electricity

A compact, experimental gaseous fuel cell recently developed converts chemical energy from an external source into electrical energy directly and instantaneously. There are no heat engine losses, and so the cell has a theoretical 100% efficiency. In trial runs, a 24-volt cell was used successfully to light two 15-watt electric light bulbs.

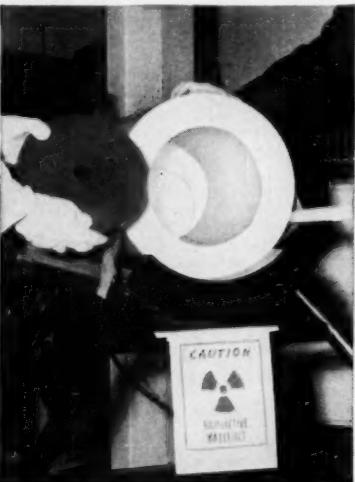
The fuel cell contains electrodes and an electrolyte, and hydrogen and oxygen are used as the fuel gases. Hydrogen is catalytically ionized at the anode—releasing electrons to the external circuit—and reacts with ions in the electrolyte. Oxygen is ionized at the cathode—absorbing electrons from the external circuit—and reacts with the electrolyte to

replace the ions used at the anode and to form water. As a result, electrons flow through the external circuit at a voltage characteristic of the chemical reaction—and light the lamps.

Polyethylene Reflector Used in Training Reactor

A small sub-critical reactor, with a core 10 inches in diameter by 14 inches long, is being used as a teaching aid at the University of Texas, to train future nuclear scientists in the use of radiation equipment and the characteristics of reactors.

The reactor uses two types of reflectors—polyethylene and graphite—with thicknesses varying from three to ten inches. During study, students will put a uranium core inside the reflector and add a neutron source. Although neutrons will be multiplied by the core, they will be retained by the reflector. When the source is removed, multiplied neutrons will die out. There is no danger to students, unless they come in close contact with the neutron source.



Uranium core being inserted into polyethylene reflector of training reactor at University of Texas (photo courtesy of Lockheed Aircraft).

PRODUCTS OF U.S.I.

ORGANIC SOLVENTS AND INTERMEDIATES

Ethylene, Normal Butyl Alcohol, Amyl Alcohol, Fuel Oil, Ethyl Acetate, Normal Butyl Acetate, Diethyl Carbonate, DIATOL®, Diethyl Oxalate, Ethyl Ether, Acetone, Acetoacetone, Acetoacetyl-Oxido-Chloranilide, Acetoacetyl-Oxido-Toluclidide, Ethyl Acetoacetate, Ethyl Benzoylacetate, Ethyl Chloroformate, Ethyl Sodium Oxaloacetate, Sodium Ethylate, ISO-SEBACIC® Acid, Sebacic Acid, Urethan U.S.P. (Ethyl Carbamate), Riboflavin U.S.P., Palogenic Acid, 2-Ethyl Heptanoic Acid.

OTHER PRODUCTS

Pharmaceutical Products: DL-Methionine, N-Acetyl-DL-Methionine, Urethan USP, Riboflavin USP, Intermediates.

Heavy Chemicals: Anhydrous Ammonia, Ammonium Nitrate, Nitric Acid,

Nitrogen Fertilizer Solutions, Phosphatic Fertilizer Solution, Sulfuric Acid, Caustic Soda, Chlorine, Metallic Sodium, Sodium Peroxide, Sodium Sulfite, Sodium Sulfate.

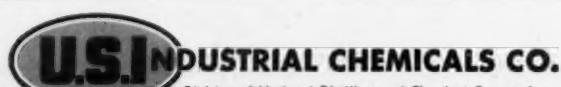
Alcohols: Ethyl (pure and all denatured formulas); Proprietary Denatured Alcohol Solvents SOLOX®, FILMEX®, ANSOL M, ANSOL PR.

PETROTHENE® Polyethylene Resins

Animal Feed Products: Antibiotic Feed Supplements, BHT Products (Antioxidant), Calcium Pentothenate, Choline Chloride, CURBAY B-G®, Special Liquid CURBAY, VACATONE®, Menadione (Vitamin K₃), DL-Methionine, MOREA® Premix, Niacin USP, Riboflavin Products, Special Mixes, U.S.I. Permydrol, Vitamin B₁₂ Feed Supplements, Vitamin D₃, Vitamin E Products, Vitamin E and BHT Products.

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SPROUT-WALDRON

Pointers

for Mixing and Blending • Size Reduction
Size Classification • Bulk Materials Handling • Pelleting and Densifying

Published in the interest of better processing by Sprout, Waldron & Co., Inc., Muncy, Penna.

NEW PELLET COOLER AND DRYER

Modification of the patented Rotaircool®, developed for the economical cooling, drying and conveying of pellets, has been recently announced.

Major redesign feature is the use of a compact rotary airlock feeder beneath the tank to receive the cool or dried pellets and discharge them as required. Handling of the pellets from the pelleting to the inlet of the Rotaircool is by means of the Sprout-Waldron Pneu-Vac® negative pressure air handling system which keeps pellet breakage, dust and maintenance at a minimum.

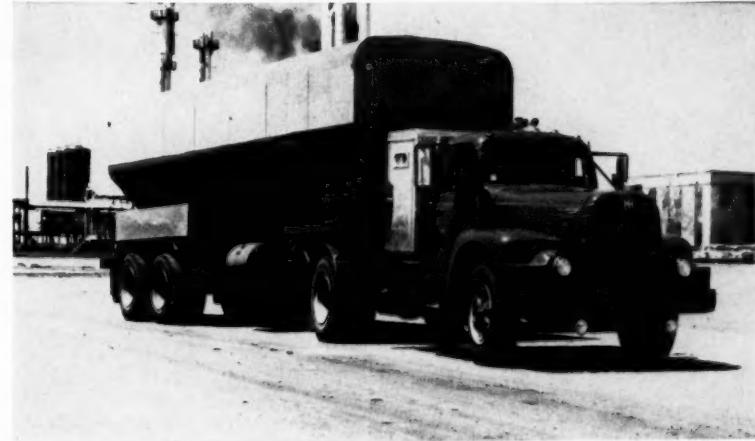


Sprout-Waldron Industrial Rotaircool for cooling, drying and pneumatic conveying of pellets.

By adding heating coils just prior to the pellet inlet, the Rotaircool® system is equally adaptable for heating or cooling. Further details in Bulletin 202.

PRACTICAL PNEUMATIC CONVEYOR DESIGN

A technical article by the Chief Engineer of our Materials Handling Division. It tells how to select, operate and maintain pneumatic systems for transporting dry, bulk materials. Positive, negative and combination systems are illustrated and described. Ask for Bulletin I-28.



One of five Sprout-Waldron Pneumatic Aluminum Bulk Trucks for handling polystyrene pellets in Cosden Petroleum's new "curb service marketing" delivery concept. Note Cosden's modern 32,000 barrel custom refinery in background.

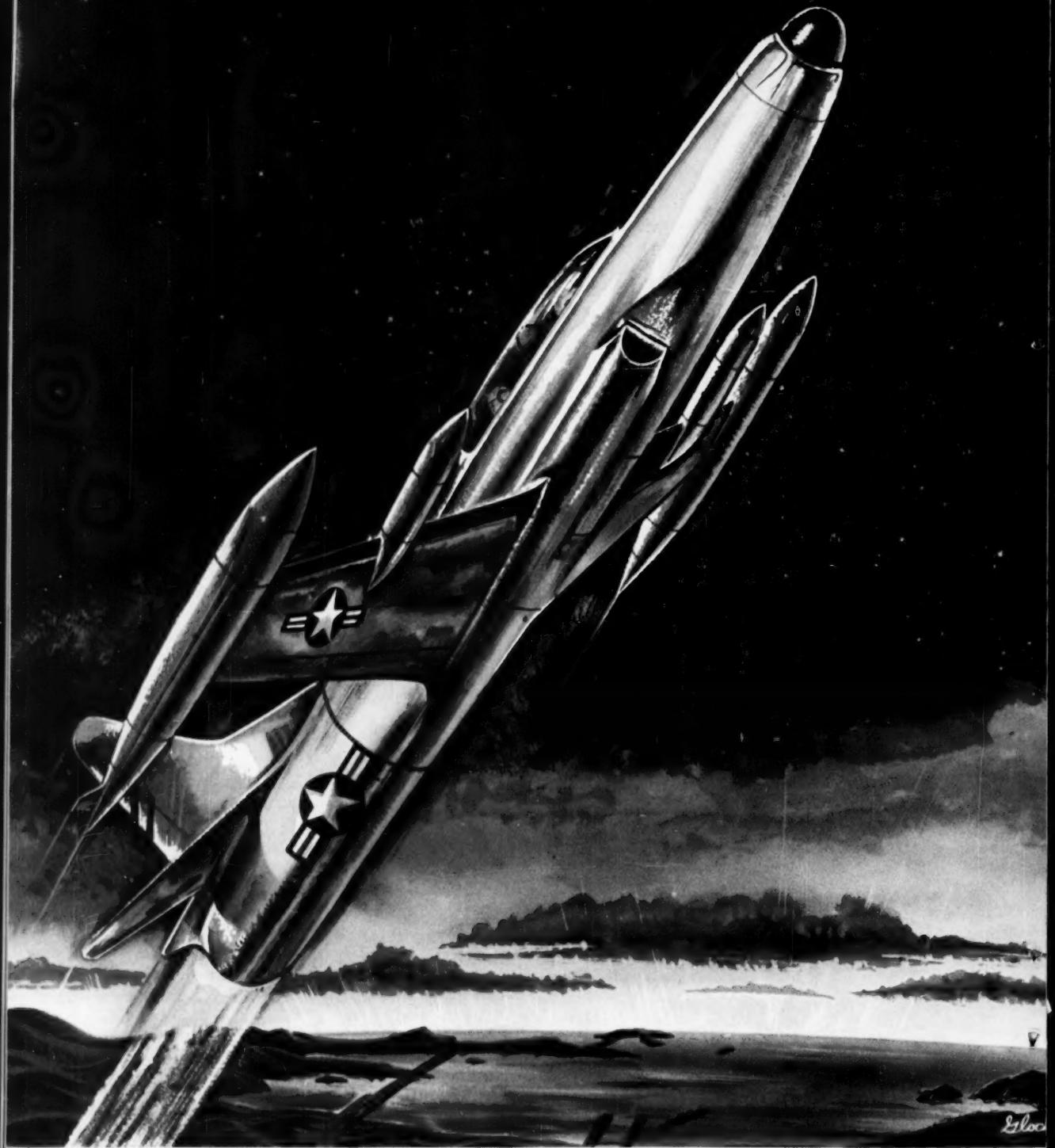
SPROUT-WALDRON BULK TRUCK HANDLES POLYSTYRENE PELLETS

A recent announcement by officials at Cosden Petroleum Corporation, Big Spring, Texas of a new delivery concept, "curb service marketing" is arousing considerable interest throughout the plastic industries. The revolutionary marketing plan involves a delivery of polystyrene pellets by special highway transports direct from the purchasing plant to the customer.

The key to the new concept is a group of five 28' pneumatic aluminum bulk trailer units designed and built by Sprout-Waldron. Each of these trailers has a capacity of 1,182 cubic feet which is equivalent to 34,000 lbs. of polystyrene pellets. The high powered unloading system permits delivery to the customer at the rate of 30 tons per hour. Delivery and storage in bulk

cuts down on fringe expenses such as unloading, warehousing, multiple handling and contamination. Bulk storage also permits instant inventory determination. Storage bins can be located at the most suitable point in the plant since the pneumatic unloading system built into the trucks permits delivery anywhere a pipe can be run.

Recent completion of the new polystyrene plant is said to make Cosden Petroleum the first producer able to integrate all phases in the manufacture of this basic material. Both general purpose crystal polystyrene and high impact polystyrene are being produced. The styrene monomer used in manufacturing polystyrene is produced in an adjacent plant also owned and operated by Cosden.



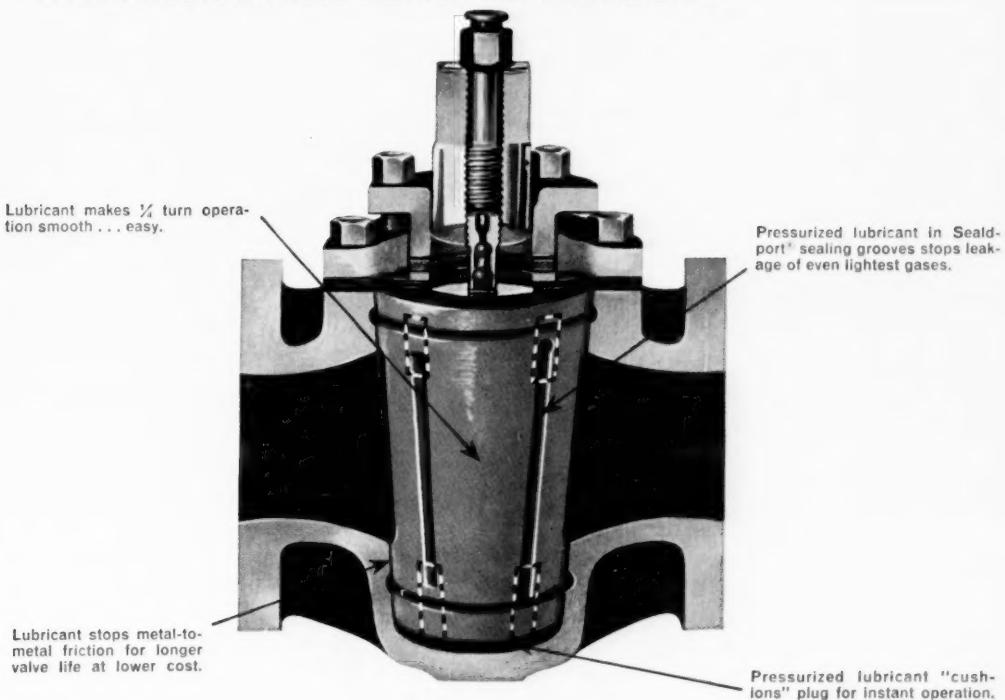
ROCKWELL-Nordstrom VALVES

How long would it fly without lubrication?

A sleek jet would be turned into a smoking, grotesque mass of junk in seconds without the proper lubrication to prevent metal-to-metal friction.

It's just common sense that wherever metal works against metal, lubrication is an investment in longer life, better performance. That's why Rockwell-Nordstrom *lubricated* plug valves stay in service longer at far lower cost than ordinary valves. But *pressurized lubrication* serves another very important function in these valves . . . it assures positively leak-proof flow control.

VALVE LUBRICATION MEANS DEPENDABILITY



Rockwell-Nordstrom is the original and world's most complete line of lubricated plug valves with sizes from $\frac{1}{4}$ " to 36" and pressures to 15,000 lb. Available at leading oil field and industrial supply houses everywhere. For details, see your supplier or write: Rockwell Manufacturing Company, Pittsburgh 8, Pa. If you live outside the U. S. A., write: Rockwell International Division, Pittsburgh 8, Pa.

©Reg. T.M. Rockwell Manufacturing Company

ROCKWELL-Nordstrom VALVES

another fine product by

ROCKWELL



How

RYKON

GREASE

has performed in seven tough applications

In just two years since introduction, **RYKON** Grease has stepped in to deliver lubrication in hundreds of applications where other greases have failed



1



2



3



4

In the process industries where higher speeds, loads, temperatures and pressures are being put on bearings as a means of increasing productivity of equipment, a new

type of grease has been needed. RYKON is that grease. Here are just seven examples of how RYKON Grease has performed in tough spots:

Industry	Equipment	Type of Bearings	Conditions	Remarks
Packing Company	can closers	various	high temperature, heavy load, wet	Outperforms previously used greases.
Brewery	washers, conveyors	various	high temperature, wet	Lasts longer and does a far better job on all applications.
Packing Company	canning machines	plain and anti-friction	wet	Very satisfactory.
Chemical Laboratory	washers and degreasers	anti-friction	wet	Better than any grease tested in degreasing solvent.
Automotive Parts Mfr.	reciprocating pump bearings	plain	wet	Pumping chemicals. O.K. after one month. Previous grease caused about one bearing failure per week.
Paper Mfr.	liquid sulfur pump	anti-friction	high temperature, wet	Has extended life of bearings.
Paper Carton Mfr.	all grease-lubricated parts	various	high temperature, heavy load, wet	Replaced eight different greases. Stays in better.

The reason RYKON Grease can perform under conditions that cause other greases to fail is this: RYKON Grease has a unique non-soap, organic thickener. This thickener holds the oil between its fibers better than any other gelling agent. The thickener is able to withstand extremely high as well as low temperatures. It resists chemical action and remains stable under conditions of severe working and water washing. RYKON Grease has exceptional anti-rust properties.

RYKON Grease's unique properties make it truly multi-purpose. This leads to many

worthwhile economies. With one grease to do possibly every grease lubrication job in a plant, there's no chance for application mistakes. Inventory and handling of many single-purpose greases is reduced or eliminated and maintenance training and supervisory follow-up is greatly reduced.

More facts about RYKON Grease are yours for the asking. Call the lubrication specialist in your nearby Standard Oil office in any of the 15 Midwest and Rocky Mountain states. Or write **Standard Oil Company (Indiana), 910 S. Michigan Ave., Chicago 80, Illinois.**

You expect more from **STANDARD** *and you get it!*



Oven test shows high temperature performance of RYKON Grease. 1. Metal panel coated with RYKON and placed in oven at 350° F. 2. Same panel after five days. RYKON is still soft and ready to lubricate. 3. Another high-melt grease ready for same test. 4. Same panel after oven test. Grease has failed completely.



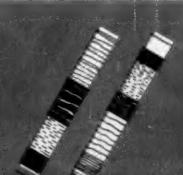
the only complete water service organization



INITIAL SURVEYS,
EXPLORATIONS,
RECOMMENDATIONS



SITE
SELECTION



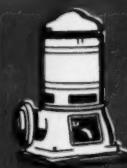
FOUNDATION AND
SOIL SAMPLING



WELL DRILLING

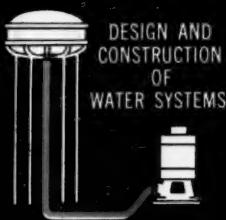


WELL CASING
AND SCREEN



PUMP DESIGN,
MANUFACTURE AND
INSTALLATION

Complete service means undivided responsibility



DESIGN AND
CONSTRUCTION
OF
WATER SYSTEMS



COMPLETE
RESEARCH STAFF
AND FACILITIES



MAINTENANCE
AND SERVICE



CHEMICAL TREATMENT
OF WATER WELLS



WATER
TREATMENT

In an age of specialization there is a definite advantage in doing business with a company offering a COMPLETE SERVICE . . . providing *all* the services allied to the field of water.

Only Layne with its network of Associate Companies, and over 75 years of experience, all backed by Layne Research can offer its customers a complete water service which makes Layne unique in the industry.

World's Largest



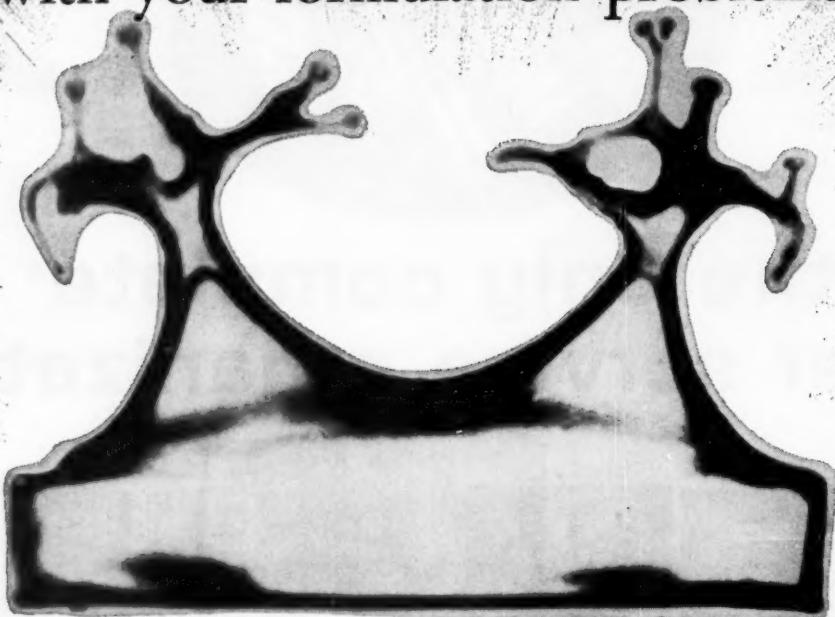
Water Developers

LAYNE & BOWLER, INC., MEMPHIS

Offices and Factory • Memphis 8, Tenn.

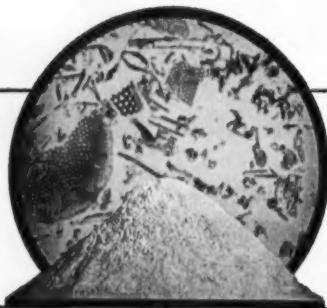
LAYNE ASSOCIATE COMPANIES THROUGHOUT THE WORLD

What's this ⁶⁶CROWN⁹⁹ got to do
with your formulation problems?



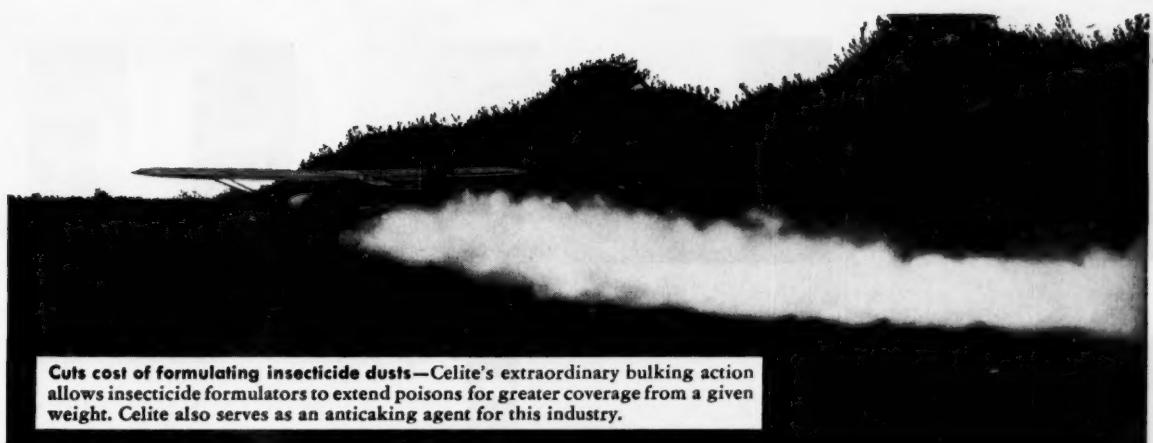
This is a particle of Celite diatomaceous earth. The genus is *Dicladia*, species is *Capreolus*. Loosely translated it means "two-sided branch." This particle is just one of hundreds of different intricate particles that together make Celite such an efficient mineral filler. When placed under a microscope *Dicladia Capreolus* becomes a rustic "crown."

It's a particle of CELITE
with a cubic foot



The secret of diatomite's remarkable properties—The infinite variety of particle shapes and sizes gives Celite diatomite its exceptional performance characteristics in a wide range of process applications. Irregular shapes like the "crown" prevent packing down for high bulking action.

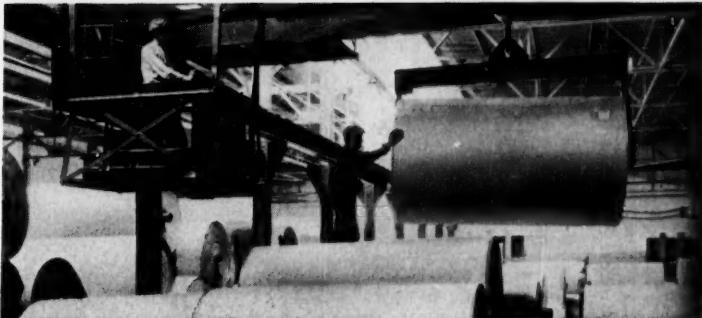
Johns-Manville CELITE



Cuts cost of formulating insecticide dusts—Celite's extraordinary bulking action allows insecticide formulators to extend poisons for greater coverage from a given weight. Celite also serves as an anticaking agent for this industry.



Controls package loss in cleansers—Cleansers and other powder products remain "fluffed up" after packaging when formulated with Celite. Celite also serves as an absorbent for detergents, wetting agents and odorants.



Adds needed bulk to paper—Because of its exceptionally low apparent density, Celite increases bulk in paper as much as 10% with a corresponding increase in machine speed. Celite is also used in paper mills to control pitch and improve brightness, opacity and ink receptivity.

—the inert mineral filler of bulk in every ten pounds

AS MUCH AS 10 TIMES greater bulk-action than any other mineral filler. That's what you get when you formulate with Celite*. Composed of microscopic irregularly shaped particles of diatomite that won't pack down, Celite contains as much as 93% air space or voids in a given volume. And with its low cost per unit volume, Celite gives you far more bulk per dollar than other mineral fillers.

Many important filler applications are derived from Celite's unique prop-

erties. Its light porous mass provides great absorptive capacity, permitting preparation of high concentrate insecticides and other liquids in a dry, free-flowing powder form. The vari-shaped microscopic particles have large surface areas which serve to extend pigments in paint and paper-making. Other important uses include molded plastics, matches, concrete, acetylene tank fillers and adhesives.

Produced from the world's purest commercially available diatomite de-

posit, Celite comes in a wide range of grades. Each grade is carefully controlled for complete uniformity.

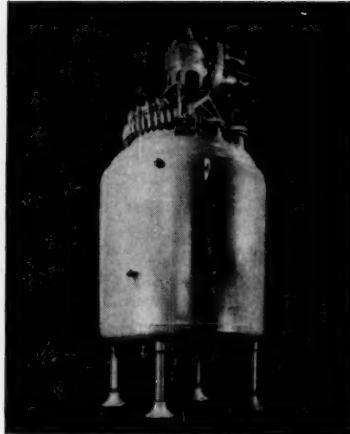
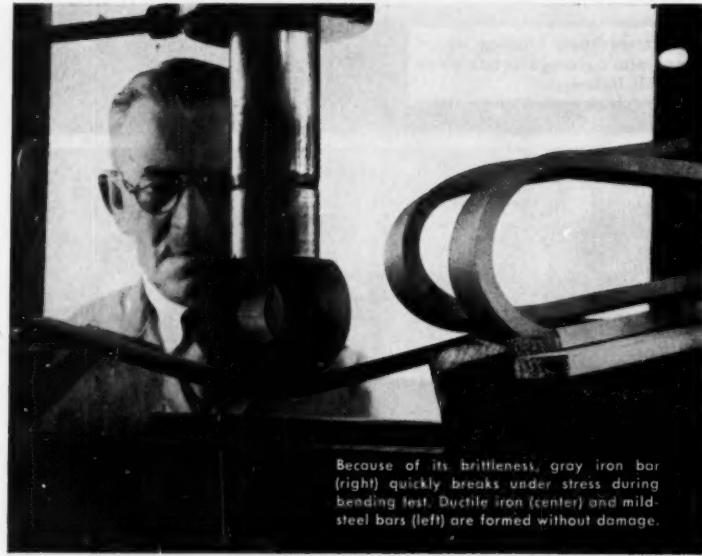
Ask your local J-M Celite engineer to tell you how Celite can help solve your formulation problems. He's backed by Johns-Manville's extensive research facilities and years of practical diatomite experience. Call him today or write Johns-Manville, Box 14, New York 16, N. Y. In Canada, write Port Credit, Ontario.

*Celite is Johns-Manville's registered trade mark for its diatomaceous silica products.

Industry's most versatile MINERAL FILLERS



FLUIDICS



NEW THROUGH FLUIDICS

Glassed "ductile iron" fittings* with strength comparable to Glasteel's

Now you can specify glassed-metal fittings and valves with the same confidence buyers have in Glasteel equipment.

New to the Pfaudler line is a series of glassed ductile iron fittings exhibiting physical and chemical properties similar to Glasteel 59's. **High Strength:** 60,000 tensile; 45,000 yield and 15% elongation per ASTM-A-395-56T and ASTM-A-339-55. Other types available on request. Ductile iron, after glassing, is 2½ to 3 times stronger than low-strength gray iron.

Improved Thermal Shock: Far superior to glassed gray iron—now comparable to the thermal shock resistance of Glasteel 59.

Excellent corrosion resistance: Resistant to all acids (except hydrofluoric) even at elevated temperatures and pressures, and to most alkaline solutions at moderate temperatures.

Acceptance: Because of its superior strength, ductile iron #60-45-15 is widely used in the petroleum industry.



If you've wanted the corrosion resistance and strength of glassed metal, but have ruled out gray iron fittings, you'll want to inquire about glassed "ductile iron" fittings from Pfaudler.

To get the information, just circle the "A" on the coupon.
*Pat. Pending

Availability: July 1st delivery on these types and sizes: 45° and 90° elbows, tees and crosses in 1½, 2, 3, 4 and 6 inch.

FLUIDICS AT WORK

30% more thermal shock protection with R Series Reactors

Thanks to Glasteel 59, today's R series reactors give you 30% more thermal shock protection, 20% greater abrasion resistance and still longer service life than what you bought less than a year ago.

Flexibility. Whether your processing requirements involve highly corrosive acids, sticky materials, protection against product contamination, or ease of cleaning, you find a good practical answer in the R series.

Low maintenance flush valve. One-piece "glassed" head and stem resting on a glass-filled Teflon seat give positive seating and minimize product build-up.

New drives. For up to 7.5 H.P. it's the "H" type of worm gear drive. For higher power to 60 H.P. plus, it's the "HH" bevel gear drive. Both are quiet running, easily maintained and competitively priced. Former drives also available.

10 day delivery. Standard sizes range from 200 to 4,000 gallons. The 500, 750, 1,000 and 2,000-gallon sizes are prestocked for 10 day delivery.

Check "B" on coupon for more data.

FLUIDICS

**is a Pfaudler Permutit
program providing
the know-how
the equipment
and the experience
for solving problems
involving fluids.**

FLUIDICS covers such varied phases of fluid handling and control as:

- corrosion engineering
- water treatment
- waste treatment
- reactions
- polymerization
- ion exchange
- fluid analysis, metering and control
- agitation
- evaporation
- distillation
- drying
- blending
- metering
- valving
- flow rate control
- piping
- storing
- centrifuging
- filling
- heat transfer, etc.

Whenever you have a fluid-handling problem, look to this Pfaudler Permutit FLUIDICS program for the best solution.



FLUIDICS AT WORK

How ultra-high purity water helps RCA produce COLOR TV tubes

Water used for the inside surfaces of RCA color TV picture tube envelopes must be ultra pure. Even a trace of iron or copper might discolor or deaden the sensitive phosphor coating that reproduces the color picture.

At RCA's Lancaster plant, washing was first done with distilled water. When tube production outgrew the capacity of the distillation equipment, RCA put in its first manually operated ion-exchange units. When these, too, fell short of requirements, RCA called in Permutit to enlarge and modernize the complete demineralizing facilities.

Now the entire process is operated from one master control panel. There's plenty of water for production . . . and water purity is even higher than when the water was distilled.

Circle "C" on the coupon for further information.

FLUIDICS AT WORK

One year guarantee against corrosion with Glasteel 59

There's just one material of construction you can buy which carries with it a full year's guarantee against corrosion: Pfaudler Glasteel 59.

If you ever find a piece of Glasteel equipment unusable due to corrosion under specified operating conditions, during its first year after shipment we'll repair or replace it, f.o.b. the factory.

Glasteel 59 is now standard on all Pfaudler equipment for reactors, fractionation, absorption, stripping, extraction, solvent recovery, etc.

It is resistant to all acids except hydrofluoric. In most cases you can even run these acids above boiling temperatures without corrosion. Glasteel 59 is equally resistant to most mild alkalies.

For a full list of the equipment available in Glasteel 59, circle "B" on the coupon for our Buyer's Guide.

PFAUDLER PERMUTIT INC.

Pfaudler Div., Dept. CE-49, Rochester 3, New York

Circle items wanted: A B C D

Name.....

Title.....

Company.....

Address.....

City..... Zone..... State.....

"PEERLESS PUMPS IT BEST!"

*Pump Buyers are saying this
about Peerless Process Pumps—*



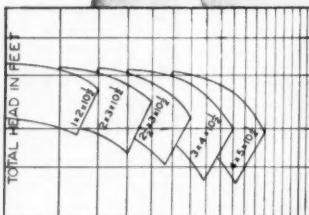
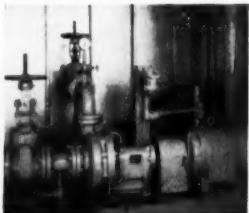
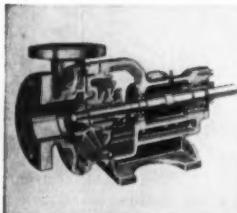
Putting Ideas to Work
FOOD MACHINERY AND CHEMICAL CORPORATION

Peerless Pump Division

Plants: LOS ANGELES 31, CALIFORNIA and INDIANAPOLIS 8, INDIANA
Offices: New York, Atlanta, St. Louis, Phoenix, San Francisco, Chicago, Fresno, Los Angeles, Plainview and Lubbock, Texas; Albuquerque. Distributors in Principal Cities. Consult your telephone directory.



HERE ARE 4 CONVINCING REASONS WHY:



THEY OFFER the type of quality construction that measures up to any standard. Continual checking at every stage of manufacture guarantees the buyer performance he can count on in the field. *The best!*

THEY PROVIDE the performance you expect and pay for, backed by actual operating records of Peerless pumps in installations like yours. Durability, dependability, efficiency—all proved in service.

THEY MEET exactly every pumping requirement, handle any job in your system that calls for a pump. The complete Peerless range offers all types of chemical process pumps, in all sizes and frames.

AN EXAMPLE of Peerless research is this recently released bulletin on the effects of radial loads in process pumps, "MECHANICAL CONSIDERATION IN PUMP DESIGN." Request Bulletin No. EM-79.

Now... you can have Grinnell-Saunders Diaphragm Valves of

Ductile Iron with Glass- Lined Bodies

After long research, Grinnell has available top quality, corrosion-resistant glass lined bodies for its line of rugged ductile iron valves.

EXTRA TOUGHNESS The greater toughness of ductile iron resists impact, torsion, line strains and thermal shock. Grinnell-Saunders valves of ductile iron handle severe service requirements where both internal and external impact shocks may be expected, and where piping stresses from rapid heating and cooling occur.

ECONOMY Approved and used by leading industries, ductile iron offers many of the benefits of cast steel at a lower price.

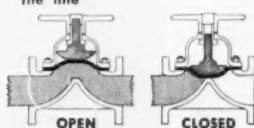
Of particular importance to users of Grinnell-Saunders valves is that ductile iron bodies can now be *glass-lined*—a procedure not practical with cast steel bodies.

WIDE SELECTION Body linings: glass, rubber, neoprene. Diaphragms: soft natural rubber, natural rubber, white synthetic rubber, neoprene, reinforced neoprene, butyl, Hycar, Teflon, Kel-F, PVC (polyvinyl chloride), polyethylene. Bonnet materials: ductile iron, grey iron. Bonnet styles: handwheel (non-indicating stem or indicating stem), chain wheel, lever for quick operation, and sliding stem for a wide selection of power operated topworks.



Important features of the Grinnell-Saunders Diaphragm Valve

- Diaphragm completely isolates operating mechanism from the fluid in the line
- Diaphragm lifts high for full, streamline flow in either direction
- Diaphragm effects positive, leak-tight closure
- Diaphragm easily replaced without removing valve body from the line



GRINNELL-SAUNDERS DIAPHRAGM VALVES



Grinnell Company, Inc., Providence, Rhode Island

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

MAGIC GENIE OF THE REACTOR

HARSHAW CATALYSTS

WILL DO A GIANT'S WORK FOR YOU

Harshaw Catalysts do a giant's work and Harshaw produces catalysts in giant quantities—carloads every week. A letter or phone call will put our 20 years' experience and acres of production and research facilities to work for you.

CATALYTIC CHEMICALS SUPPLIED BY HARSHAW

Aluminum Nitrate	Cobalt Nitrate	
Copper Nitrate	Manganese Nitrate Solution	
Metallic Soaps (Cobalt, Manganese)		
Nickel Carbonate	Nickel Formate	Nickel Nitrate
Nickel Sulfate	Sodium Methoxide	Zinc Nitrate

Our experienced technical staff will assist you in developing the best and most economical catalyst. If you have a catalytic process in the development or production stage, a discussion with us may prove beneficial.

PREFORMED CATALYSTS

to fit special process requirements

Hydroforming	Dehydrogenation	Alkylation
Cyclization	Dehydration	Hydrogenation
Oxidation	Desulphurization	Hydro treating
	Chlorination	

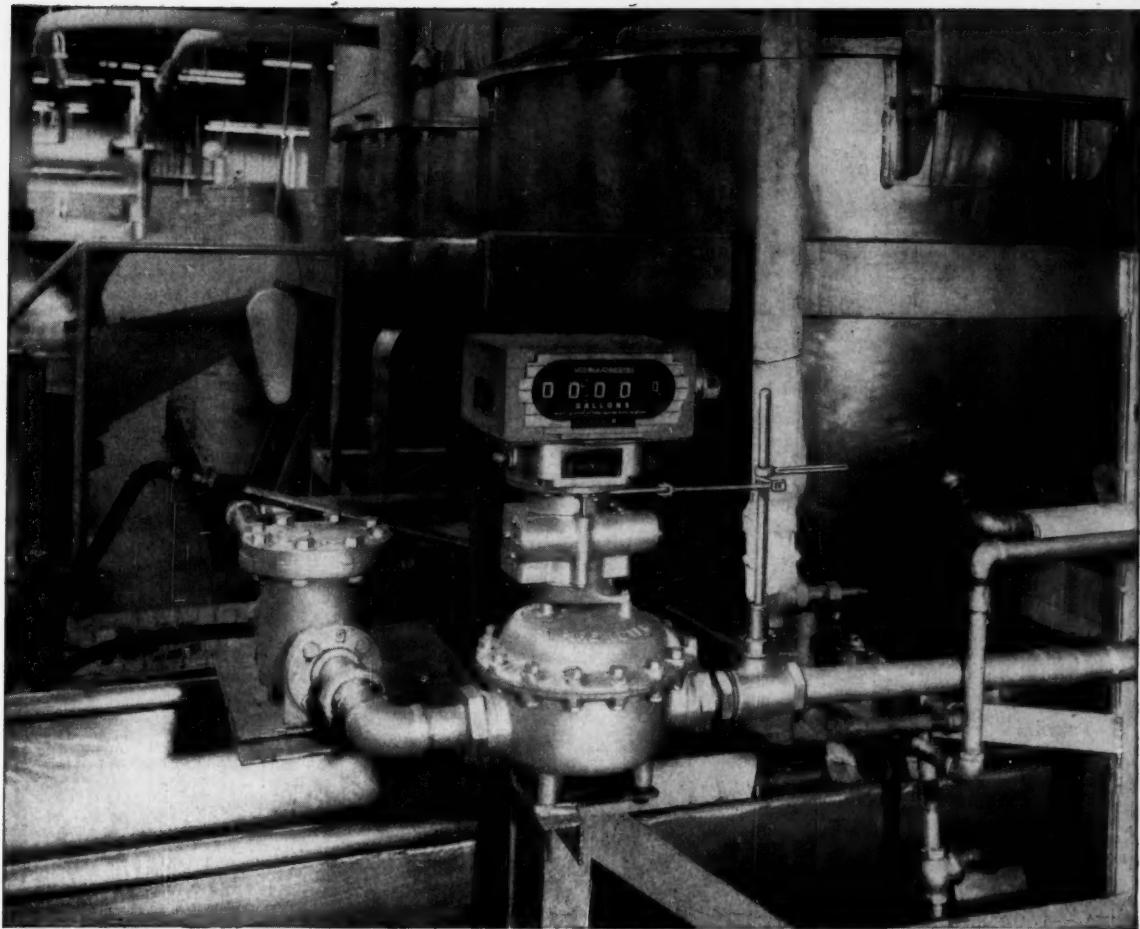


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Rockwell Model ER Meter with automatic quantity control shut-off in food processing plant

Batch it, blend it, or just plain account for it!

IT'S GOOD BUSINESS TO METER ALL LIQUIDS

Wherever liquids are stored, mixed or used in plant operations, you can save time, money and improve efficiency with Rockwell industrial meters. With meters you can batch, blend and control formulas with precision. Handling volatile liquids, metering provides the safety of a closed piping system and guards against contamination.

Rockwell industrial meters are valuable accounting tools. Thousands use them for in-plant cost identification purposes, for inventory control—even to guard plant security.

You can measure most any piped liquid with Rockwell meters—oils, liquors, paints, chemical solutions—over 50 liquids in all. Use the coupon for full details.

CLIP COUPON—MAIL TODAY!

INDUSTRIAL METERS

another fine product by

ROCKWELL



ROCKWELL MANUFACTURING CO.

Pittsburgh 8, Pa.

Gentlemen:

I am interested in measuring _____ (Name of Liquid)

Pipe Size _____ " (Inches)

Working Pressure _____ psi Temperature _____ °F max.

Max. Flow Rate _____ gpm Min. Flow Rate _____ gpm

Your Name _____

Company _____

Street _____

City _____ Zone _____ State _____

KENNEDY

PNEUMATIC CONVEYING SYSTEM

For over twenty-five years, KENNEDY has designed and built pneumatic conveying systems for America's largest industrial concerns. Let us show you how a KENNEDY System can be the most economical for your plant.

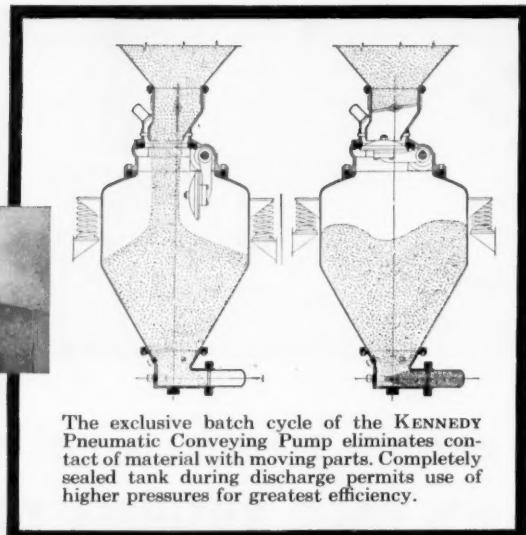
- has NO MOTORS, screws or high speed moving parts
- uses higher pressures for greater efficiency and smaller pipelines
- uses air only when moving material at full capacity
- automatically measures quantities conveyed
- can handle several materials through one pump and pipeline without contamination

TYPICAL MATERIALS HANDLED

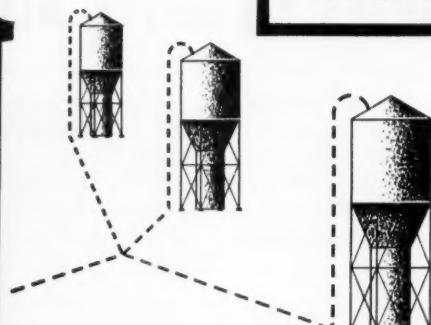
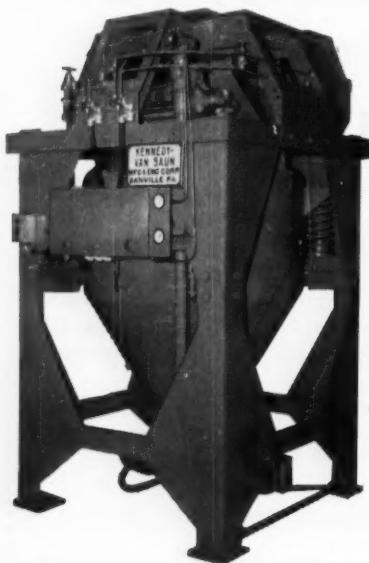
Carbon black	Lump lime
Hydrated lime	Cement
Petroleum coke	Barium sulphate
Aspirin crystal	Sodium bicarbonate
Soda ash	Anthracite coal
Dolomite	... and many others

The KENNEDY Pneumatic Conveying System requires less maintenance because:

- only these small, inexpensive parts are subject to wear;
- these parts are readily accessible—replacement is a matter of minutes;
- you get months of high capacity operation without attention.



The exclusive batch cycle of the KENNEDY Pneumatic Conveying Pump eliminates contact of material with moving parts. Completely sealed tank during discharge permits use of higher pressures for greatest efficiency.



Send for literature describing KENNEDY Pneumatic Conveying Pumps, Air Activated Containers, Air-Float Air-Gravity Conveyors, Complete Pneumatic Conveying Installations, and Research and Testing Services.



KENNEDY VAN SAUN

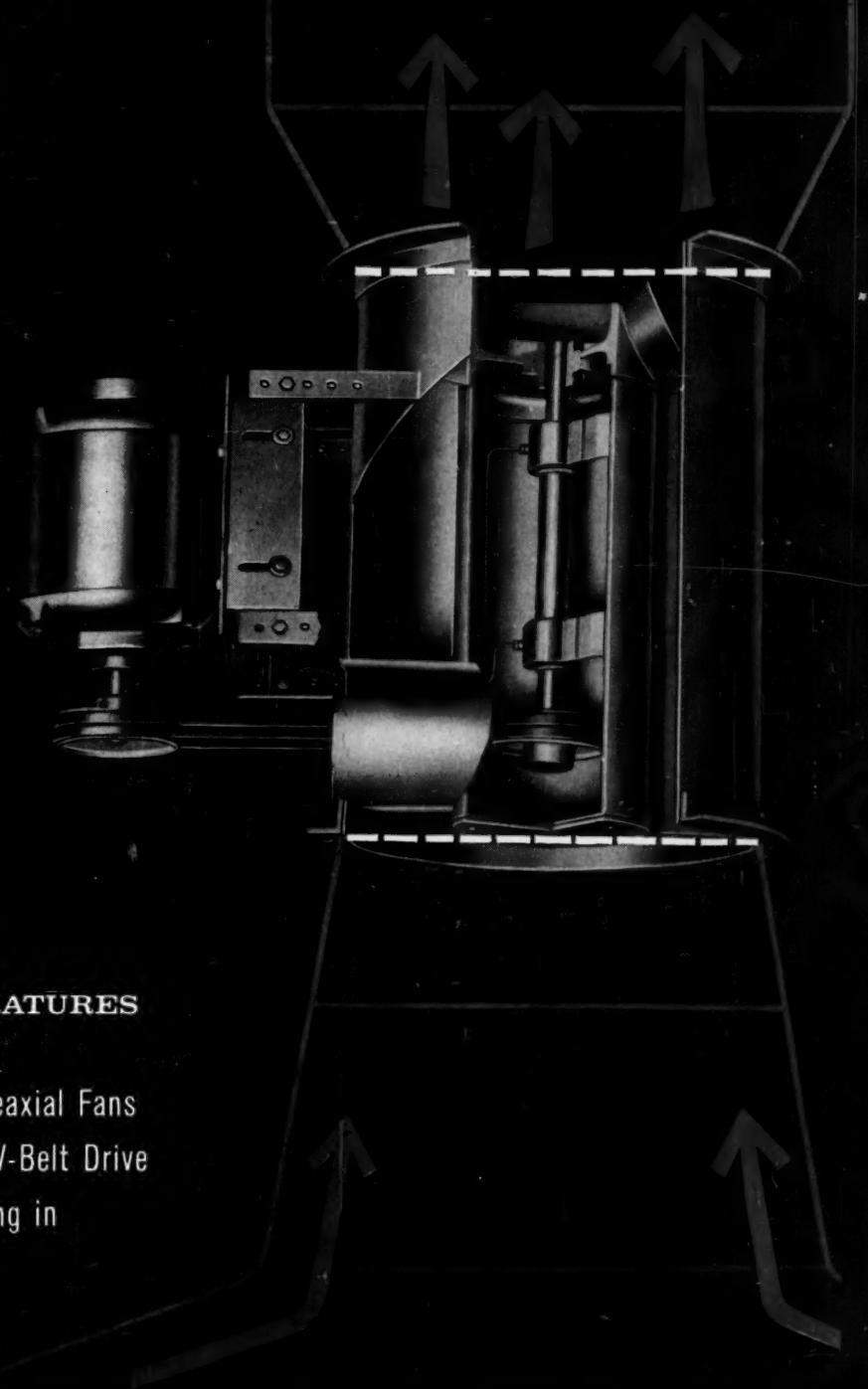
MANUFACTURING & ENGINEERING CORPORATION
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When you need
**axial
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fans**

for
exhaust
of fumes
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vapors...

FOR
STANDARD AIR
CORROSIVE GASES
ELEVATED TEMPERATURES

Specify Westinghouse Tubeaxial Fans
complete with motor and V-Belt Drive
ready for "in-line" mounting in
duct or stack

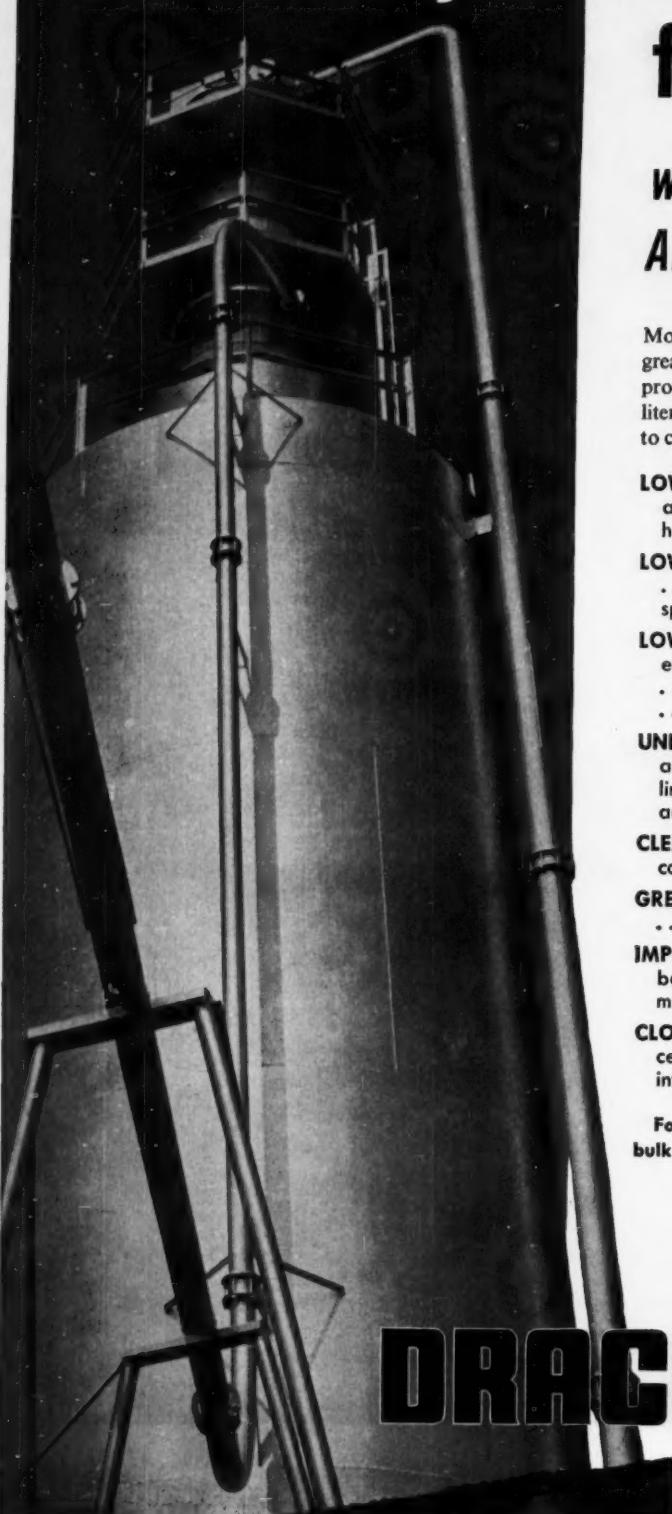


Call your nearest Sturtevant Division Sales Engineer,
or write Westinghouse Electric Corporation,
Dept. G-4, Hyde Park, Boston, Massachusetts.

J-80641-R



**YOU CAN BE SURE...IF IT'S
Westinghouse**



modernize your

bulk handling facilities

***with Dracco
Airstream Conveyors***

Modernized bulk materials handling offers the greatest potential for cost reduction and increased productivity. Dracco Airstream Conveyors handle literally hundreds of dry, bulk materials—from coal to corn flakes—and provide these cost-saving benefits:

LOWER LABOR COSTS with automatic operation and one-man supervision . . . no costly manual handling . . . no extra or unnecessary handling steps.

LOWER MATERIAL COSTS through bulk purchasing . . . no loss from spillage or broken bags . . . no spoilage from moisture or contamination.

LOWER MAINTENANCE COSTS through sound engineering, simple design and rugged construction . . . minimum repair and lubrication requirements . . . reliable long-term operation.

UNLIMITED FLEXIBILITY since space-saving systems adapt to new or existing plants . . . conveying lines can be located anywhere . . . no costly auxiliary handling methods needed.

CLEANER PLANTS since Airstream Systems are completely enclosed and dust-free.

GREATER SAFETY with no hazardous moving parts . . . no workmen exposed to toxic materials.

IMPROVED PRODUCT QUALITY from accurate batching and weighing . . . no intermixing of materials . . . no contaminating dusts.

CLOSE INTEGRATION WITH PRODUCTION with centralized, automatic control . . . processes tied into one coordinated operation with no waste motion.

For expert consultation on the modern answer to your bulk handling problem, call in a Dracco engineer today.

D R A C C O DIVISION OF
FULLER CO.
4040 East 116th Street • Cleveland 5, Ohio

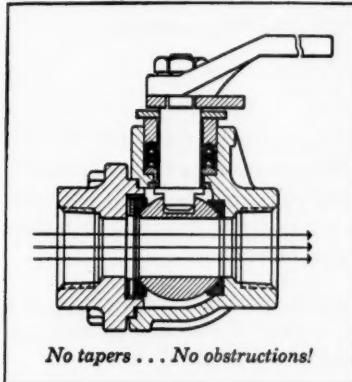
D R A C C O *airstream conveyors*
dust control equipment

(Pronounced
Dray-co)



Today's most streamlined valve!

*The Rockwood Ball Valve
...only valve with
full, round flow*



You can practically forget about turbulence, friction loss, and plugging-up when you install a Rockwood Ball Valve. In "open" position, it offers little more resistance to flow than a cross-section of the pipe in which it is installed!

What's more, positive-seal design assures leakproof service over a wide range of pressures, temperatures, viscosities, particle sizes, etc. Ball is not fastened to the shaft . . . it literally floats, to assure best alignment with seat. At low pressures, a spring behind the ball positions it snugly against a resilient synthetic rubber seat. Increased pressure

merely assists the action . . . the higher the pressure, the tighter the seal. In addition, ball's wiping action keeps seat free of foreign matter, a common cause of leaks in many ordinary valves.

The Type 316 Stainless Steel Ball Valve shown here is specifically designed for chemical service with adjustable chevron teflon stem seals, 316 stainless steel ball, spring, and handle shaft. For temperatures from -100°F to +400°F. Rating: 600 psi — W.O.G. Sizes $\frac{1}{2}$ " thru 2". Listed by Underwriters' Laboratories, Inc. For details on the line of Rockwood Ball Valves, send coupon.

ROCKWOOD BALL VALVES

FULL, ROUND FLOW

Distributors in all principal industrial areas

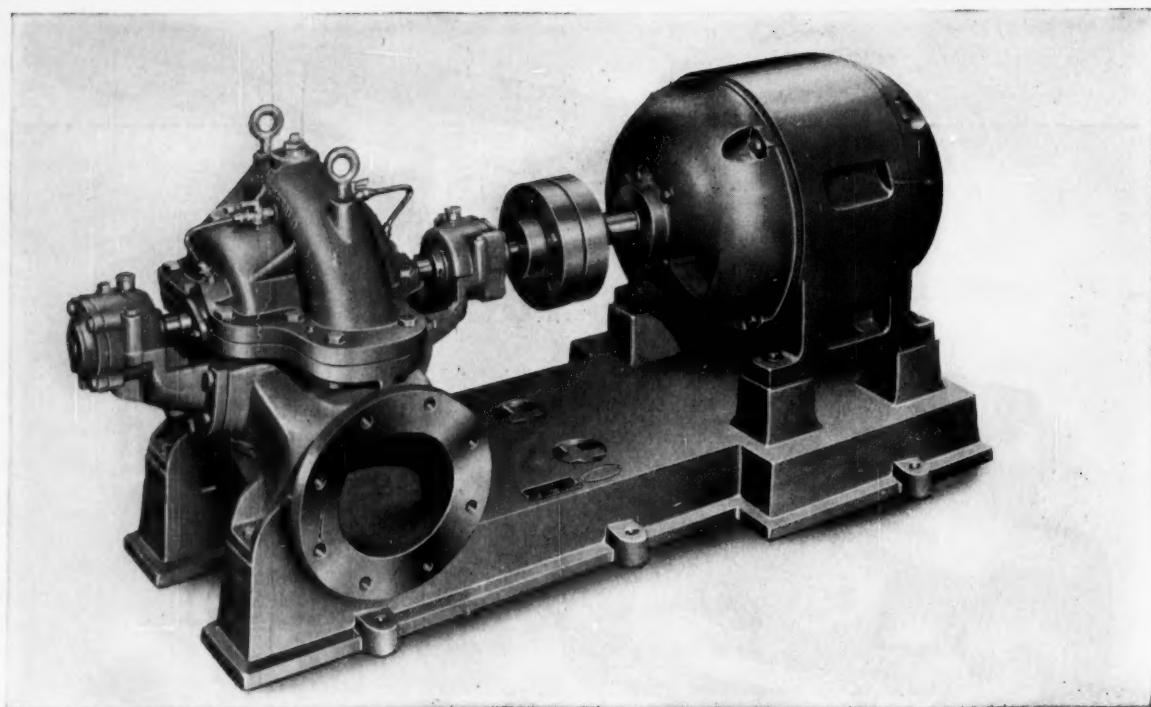
ROCKWOOD SPRINKLER COMPANY

1070 Harlow Street
Worcester 5, Mass.

Please send me new Catalog 59 on Rockwood Ball Valves.



Name.....
Title.....
Company.....
Street.....
City..... Zone..... State.....



"Buffalo" Double Suction Pump for Clear Water Service

3-WAY ECONOMY WITH THESE "BUFFALO" PUMPS

1. Minimum Maintenance Cost

2. Minimum of Costly Time-Outs

3. Minimum Service Costs

"Buffalo" Double Suction Pumps bring you these and many more economies because they combine superior hydraulic design with the finest quality workmanship and materials.

Lower maintenance cost and fewer expensive time-outs are the result of these "Buffalo" construction features: sturdy, machined casing with ample, simply-formed water passages — hydraulically balanced impellers assuring peak efficiency — renewable bronze wearing rings — heavy-duty ball bearings and shaft is high grade steel, machined all over, bronze covered, or solid monel metal or other alloy.

Lowest possible service costs are assured by the extra accessibility designed into these pumps. Horizontally-divided casing permits quick removal of the upper half. Thus interior parts can easily be inspected or removed without disturbing pipe connections.

Add to these economies peak efficiency and dependability and you have a pump that is unsurpassed for the most severe industrial clear water service.

For full information on the "Buffalo" Double Suction Pump, contact your nearby "Buffalo" engineering representative. Or write for Bulletin 955-S.



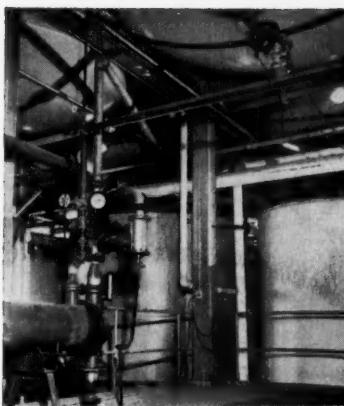
BUFFALO PUMPS

Division of Buffalo Forge Co.

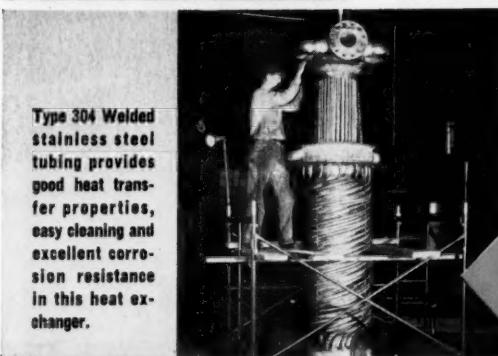
501 BROADWAY • BUFFALO, N. Y.

Canada Pumps, Ltd., Kitchener, Ont. • Sales Representatives in all Principal Cities

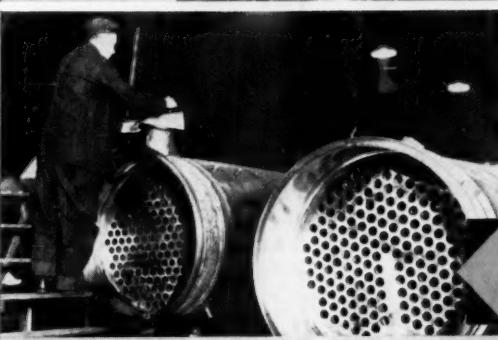
A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID



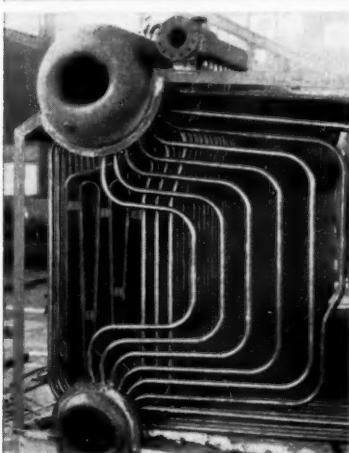
Welded stainless steel 2", 3" and 4" Schedule 5 IPS in liquid sugar line service for ease of cleaning, non-contamination of product.



Type 304 Welded stainless steel tubing provides good heat transfer properties, easy cleaning and excellent corrosion resistance in this heat exchanger.



The uniform wall thickness and ductility of welded carbon steel tubing assures uniform rolling-in and tight joints at the tube sheet.



Welded carbon steel tubing used in a superheater for 30,000#/hr. steam generator with 305°F feed water for 50°F superheat. Tubes are 2" O.D.



In Critical Heat Exchanger Applications

Use

WELDED TUBING

- CARBON
- HIGH ALLOY
- STAINLESS

There's a type of Welded Carbon, High Alloy or Stainless Steel Tubing to meet all code and customer specifications with economy.

The inherent properties of Welded Tubing include uniformity of structure, wall thickness, concentricity and dimensional accuracy unmatched by tubing produced by any other method. Your quality tube producer offers the size and grade for your most exacting requirements. Specify quality Welded Steel Tube.

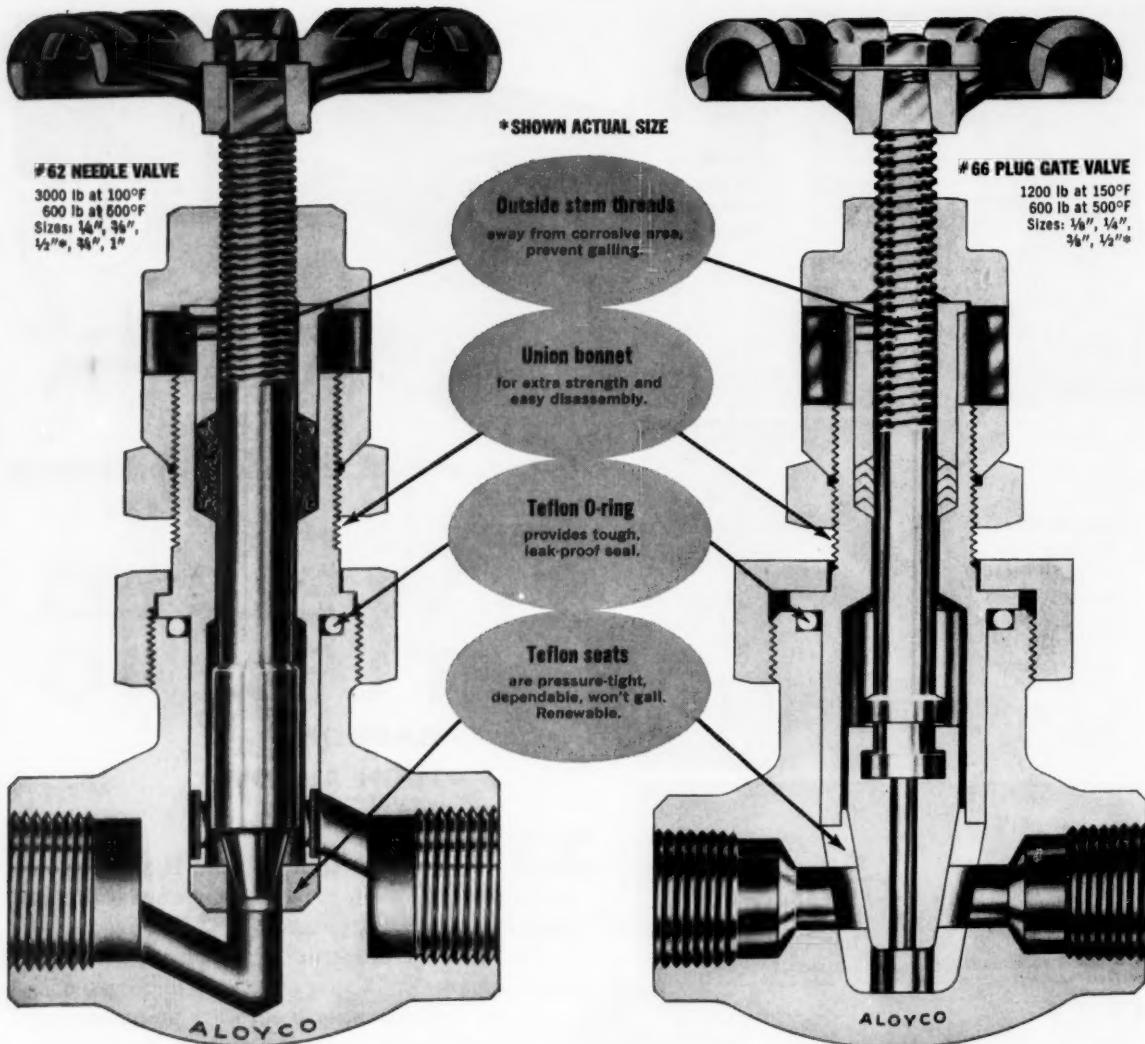
**Write for
Bulletin 8591 "Welded Steel Tubing"**



**850 HANNA BUILDING
CLEVELAND 15, OHIO**

- Armco Steel Corp. • The Babcock & Wilcox Co., Tubular Products Div.
- The Carpenter Steel Co., Alloy Tube Div. • Clayton Mark & Co. • Damascus Tube Co. • Jones & Laughlin Steel Corp., Electricweld Tube Div. • National Tube Div., United States Steel Corp. • Ohio Seamless Tube Div. of Copperweld Steel Co. • Republic Steel Corp., Steel and Tubes Div. • Revere Copper and Brass Inc., Rome Manufacturing Company Div. • Sawhill Tubular Products, Inc. • Southeastern Metals Co. • The Standard Tube Co. • Standard Tube and T. I. Ltd., (Canada) • Superior Tube Co. • Trent Tube Co., Subs. Crucible Steel Co. of America • Wall Tube & Metal Products Co.

LC-597



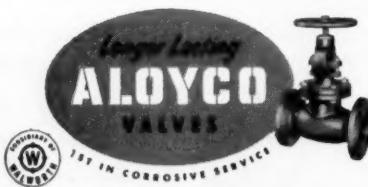
radically different ALOYCO Stainless Steel Valves eliminate leakage and galling common to ordinary fine control valves

Introduced eight years ago, these two small Aloyco valves have proved themselves in many types of severe corrosive service as well as handling hard-to-hold fluids and high-pressure gases.

The No. 62 Needle Valve (left) is particularly suitable for sensitive control of flow . . . as in metering or sampling for process plant, laboratory or pilot plant use.

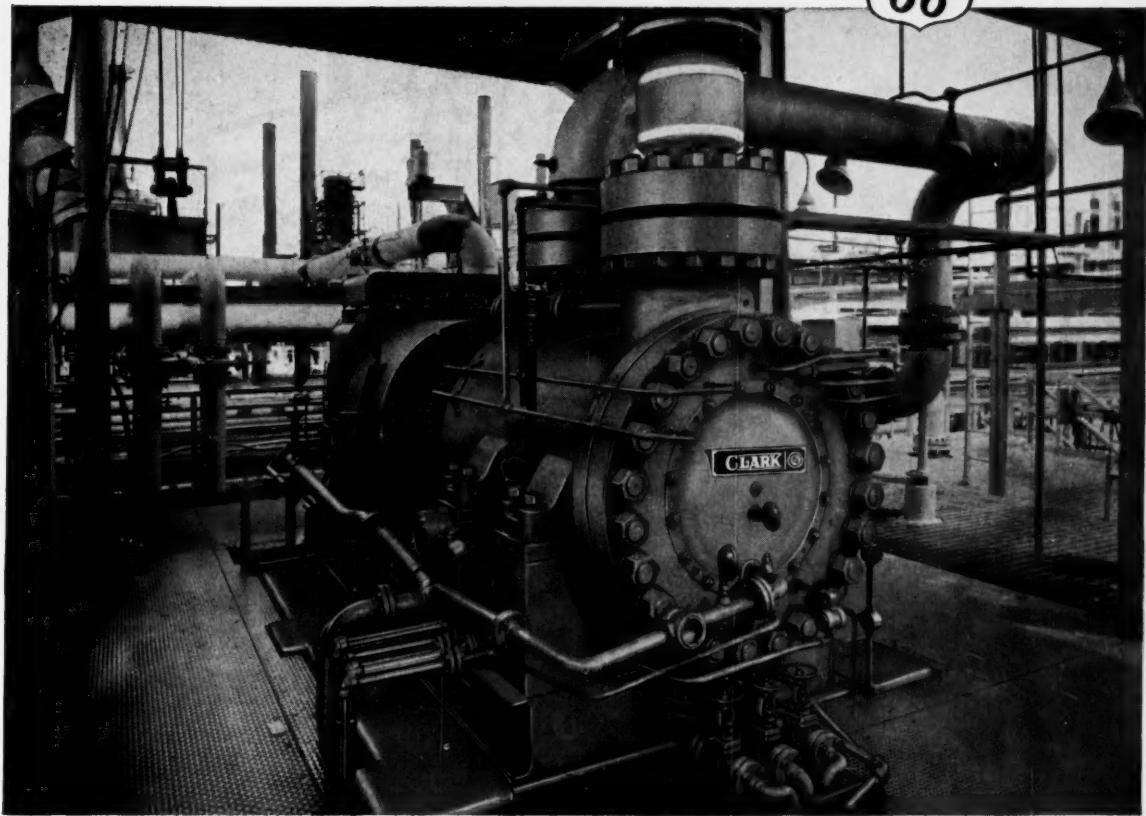
The No. 66 Gate Valve has a vented, full-floating plug disc, which exerts no twisting action on the removable Teflon seat in closing. It is ideal for instrument lines, in small lines handling viscous liquids, or where a low pressure drop is important.

For more facts write to Alloy Steel Products Company, 1301 West Elizabeth Avenue, Linden, New Jersey...the one manufacturer specializing in Stainless Steel Valves exclusively.



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AT PHILLIPS PETROLEUM CO.



First full-scale PENTANE ISOMERIZATION plant uses Clark Barrel-Type Centrifugal Compressor

Isomerize normal pentane to permit the use of natural gasoline as a high octane blending stock? Why not, said Phillips Petroleum Company. Normal Pentane was one of the remaining major components of natural gasoline that could be upgraded. Furthermore, the low sensitivity of isopentane together with its high octane level made it an ideal blending agent in premium gasoline.

By-passing the usual prototype size unit, Phillips built the industry's first full scale pentane isomerization plant. The plant uses Universal Oil Products Company's Penex Process employing a platinum-containing catalyst. With a design capacity of 34,400 bbl. per day of pentane reactor feed, the plant can produce about 16,000 bbl. per day of 95% isopentane. Startup was smooth and design yields were quickly reached.

To handle the hydrogen recycle phase of the process at the Borger, Texas plant, a Clark Vertically-Split Multi-Stage Centrifugal Compressor was selected. While the ratio of hydrogen to hydrocarbon is low in this process, the high feed capacity requires 2,000 hp for hydrogen circulation. As in many other similar processes, the performance of this Clark compressor has from startup met the rigid design requirements.

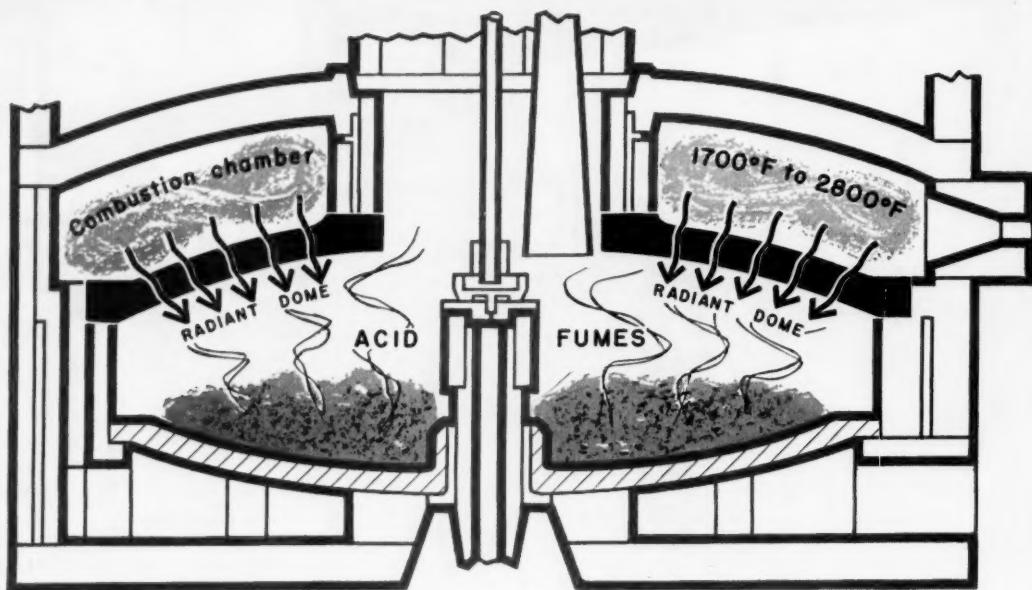
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For complete details
on Clark Vertically-Split Compressors,
write for Bulletin 150.

COMPRESSORS AND GAS TURBINES
CLARK BROS. CO., OLEAN, NEW YORK

It took one of Carborundum's refractories to solve this problem:



Delivers heat fast...resists corrosion...and stands stresses over a wide temperature range

A radiant dome is used for indirect heating in the Mannheim furnace sketched above. Sulfuric acid and salt cake are fed into an externally heated chamber to produce HCl gas. Temperatures above the radiant dome range from 1700—2800 F.

The problem here is complete separation of the highly corrosive charge from the heat source by a material that can live with these destructive conditions, yet, will transmit heat very rapidly. The problem is intensified because the dome may be as large as 20' in diameter, hence must be constructed of a material with adequate strength even at extreme temperatures.

One of Carborundum's Refractories—CARBOFRAX® silicon carbide—meets all these conditions. It has exceptionally high heat conductivity (11 times better than fireclay) and is inert to most acids. Its load bearing strength at high temperatures

—300 psi at 2750 F without crushing — also enables the CARBOFRAX shapes to withstand the tremendous structural stresses involved.

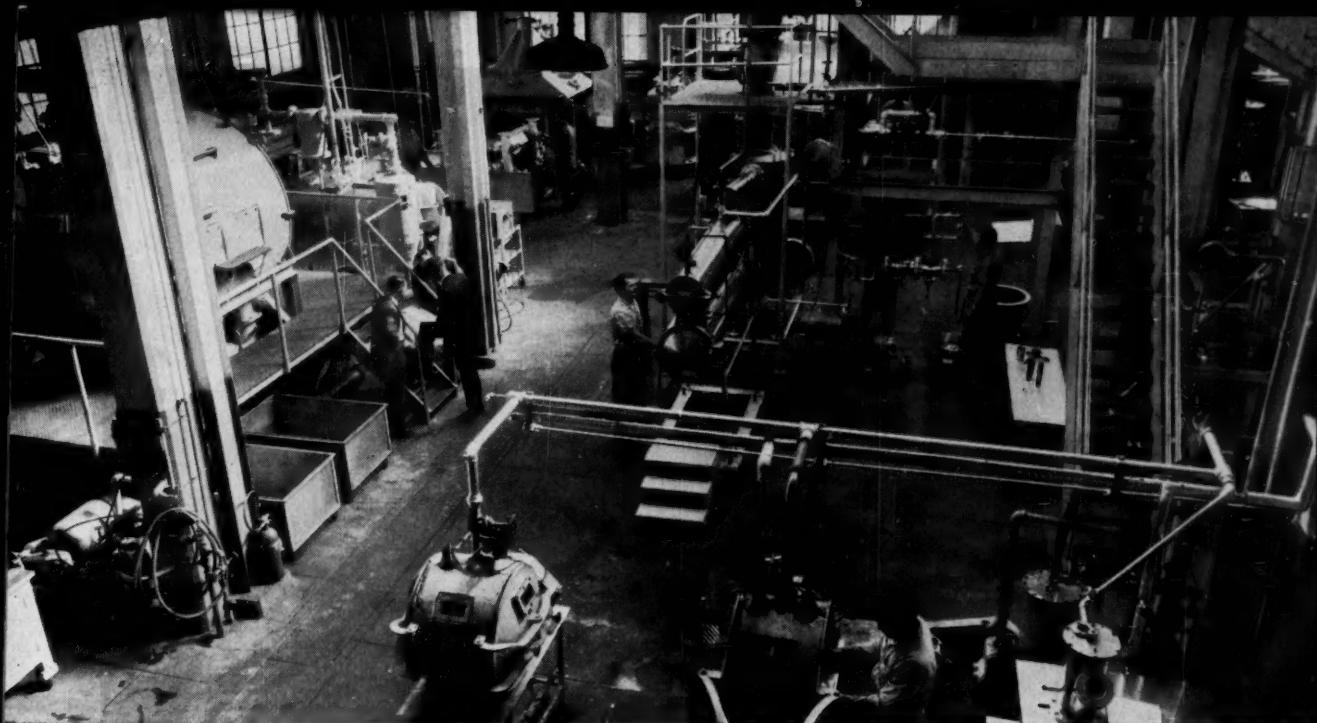
If you have a problem like this that even the best of standard refractories or metals won't handle, consider Carborundum's Refractories. There is a wide range of products, each with a combination of properties seldom found in other materials of construction.

Write today for your free copy of "Super Refractories by Carborundum."
The address: Dept. H-49, Refractories Division, Perth Amboy, New Jersey.



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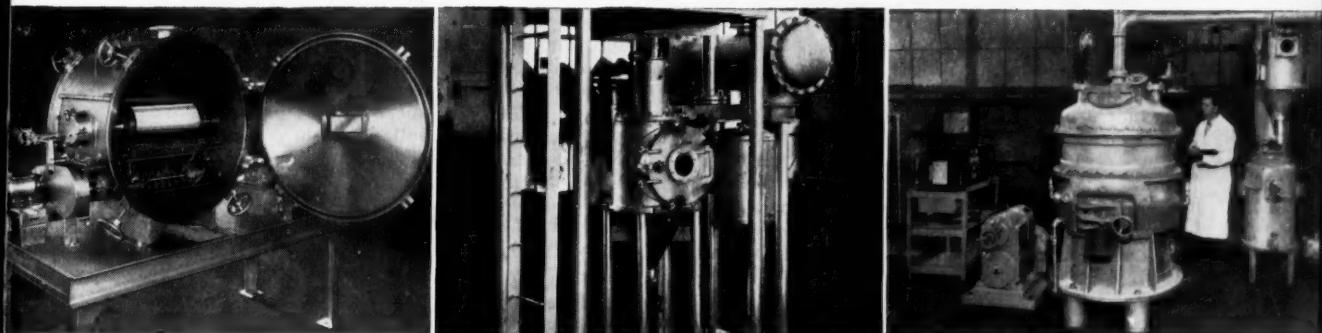
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Top equipment and a distinguished engineering staff have solved over 7,000 processing problems. See how this know-how can work for you in your own product-process research. Write for Catalog 381. Additional details also available in the Chemical Engineering Catalog, pages 429 to 452.

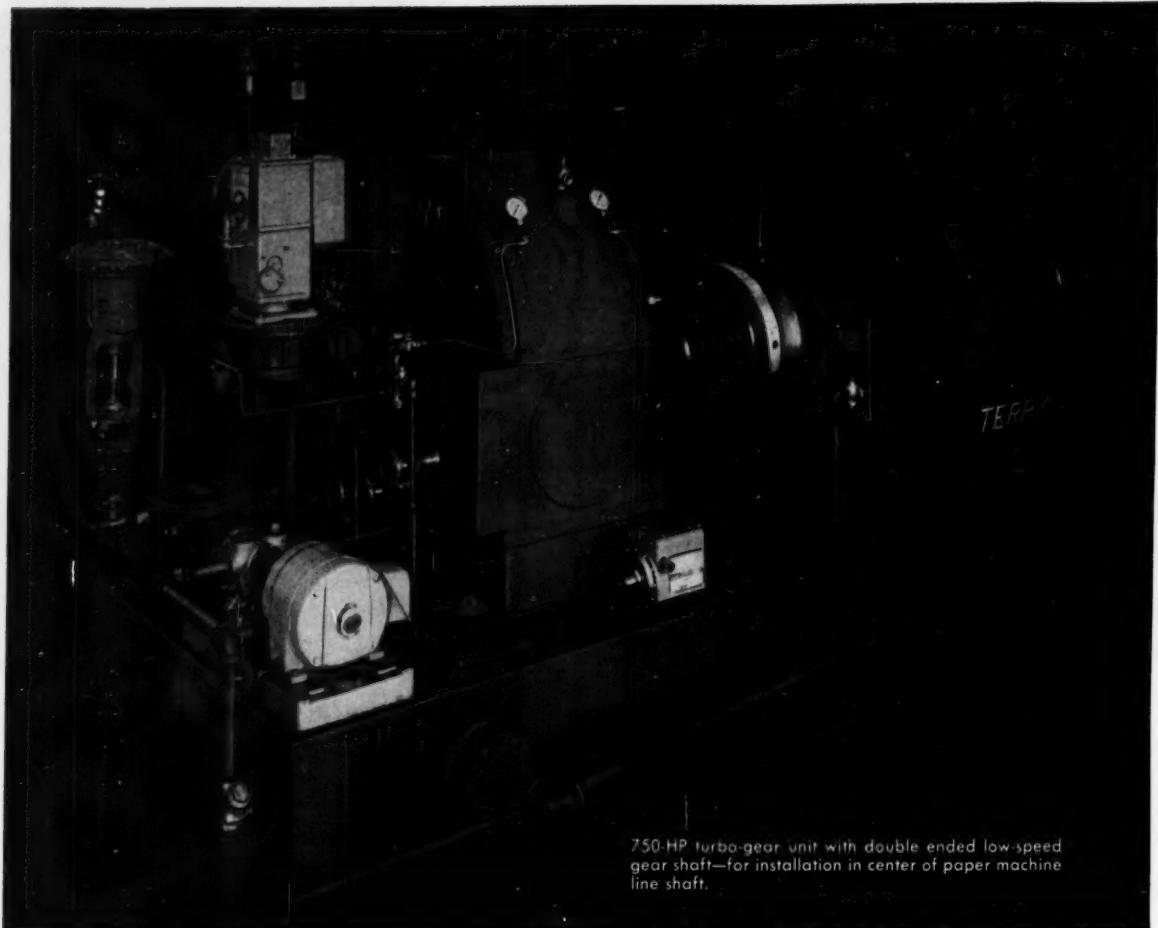


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Buflovak Equipment Division
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tailored to meet your requirements

For more than half a century, Terry has been one of the principal suppliers of turbo-gear units for driving slow-speed fans, generators, paper machines, large pumps and the like. Each unit is designed to meet the job requirements. The paper-machine drive illustrated is a good example of this *individualized engineering*.

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may be varied through a 10:1 range. Other features include forced-feed lubrication to turbine and gear bearings, and automatic shutdown and alarm in case of low oil pressure.

Whatever *your* requirements for low-speed turbine drives, a Terry engineer will be pleased to discuss them with you. Bulletin S-140 covers the full line of Terry turbines; Terry gears are described in bulletin S-130.

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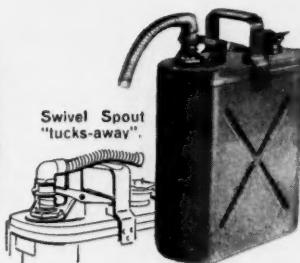
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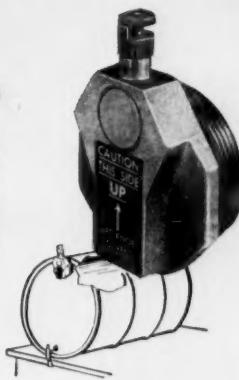
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New developments in the safe, productive use of hazardous liquids occur frequently. Often, these developments result from the needs of a single Protectoseal user—needs for which adequate safeguards did not previously exist. When these developments can be applied to operations in other plants, they are made available. The examples here are the most recent.



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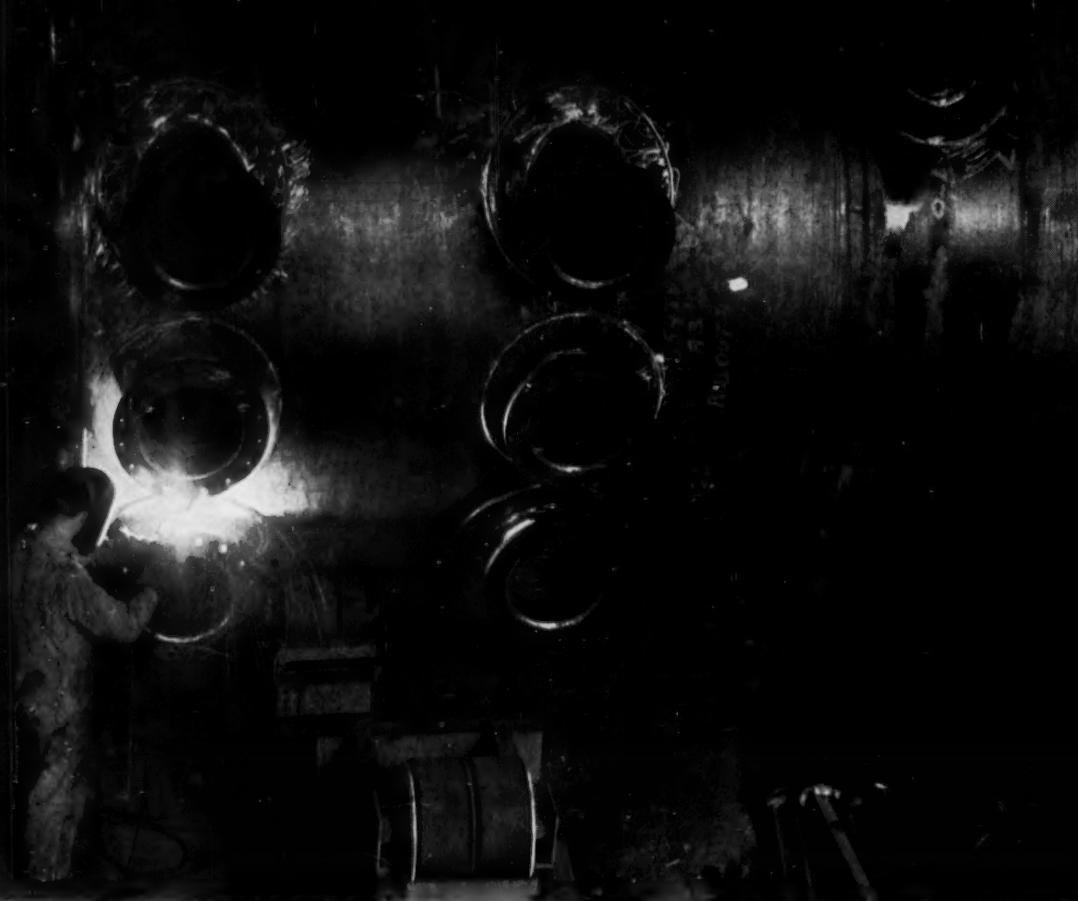
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The Business End of a Big New Vessel for DOW Petrochemicals

An expanding petrochemical plant at The Dow Chemical Company in Bay City, Michigan called for an interesting two-part processing unit—a quench water tower and a quench water tank. Designed by Bechtel for the new plant now under construction by The Austin Company, this unit was awarded to Graver for fabrication.

This petrochemical unit for Dow is one of many types of both shop-built and field-erected processing equipment which Graver fabricates for the growing petrochemical, chemical and petroleum industries. In Graver's century of experience you will find the most modern fabricating and research techniques for the processing equipment you require.

Fabricated from ASTM A-285 GC Fire Box Quality Steel in accordance with ASME code standards, the tower was shop-built and the tank field-erected. The tower was constructed to withstand a design pressure of 15 psig, the tank, 3 psig. The design temperature provided for by the tower is 650°, by the tank, 200°. All welding was spot radiographed. Before leaving the shop, the tower was sandblasted and painted with one coat of lead chromate primer.

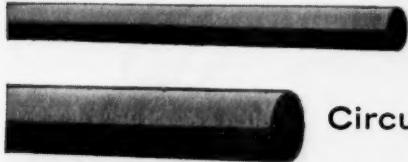
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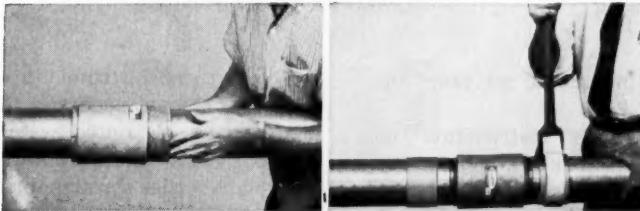


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114

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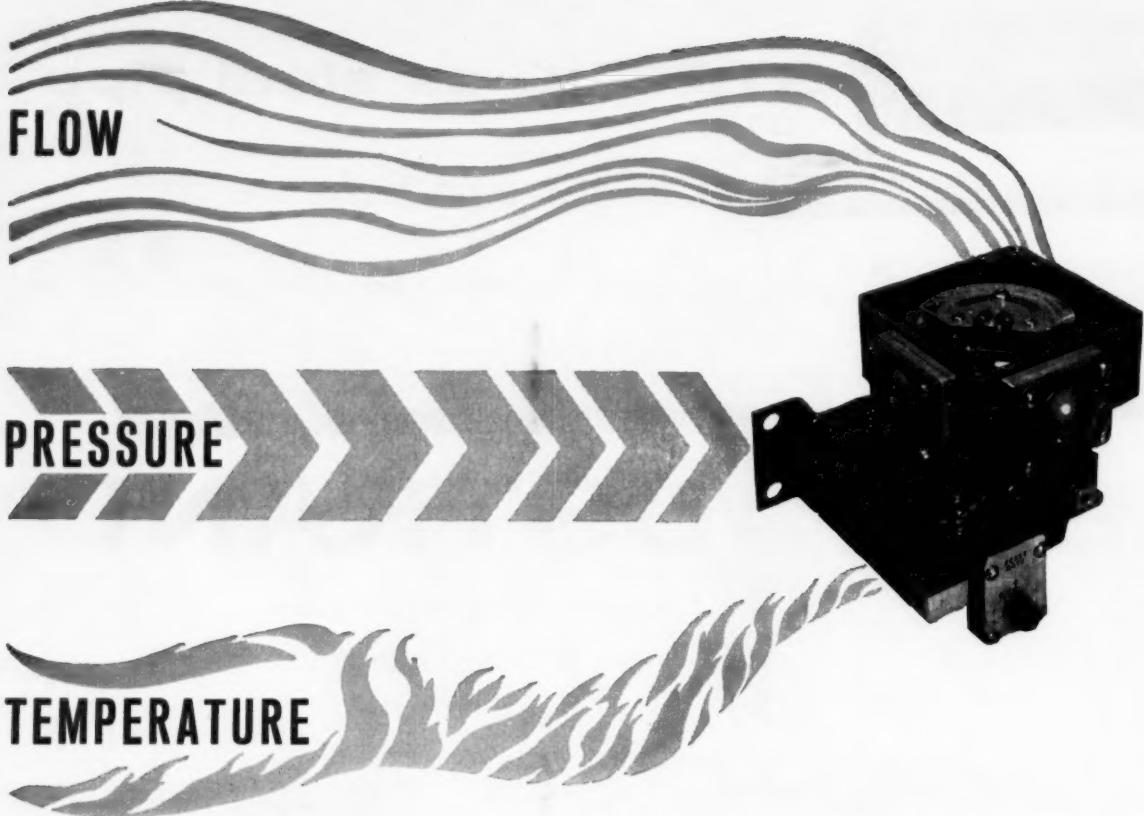
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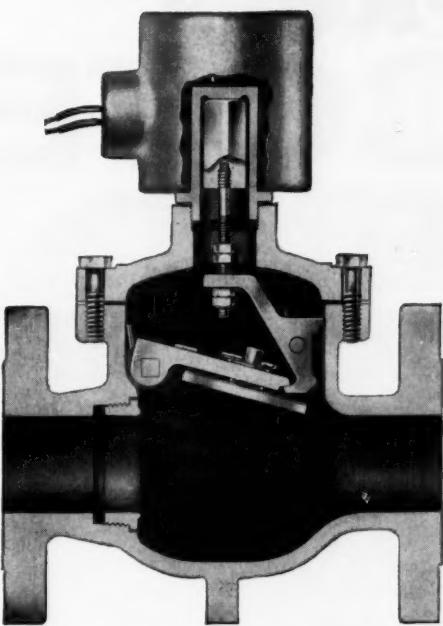
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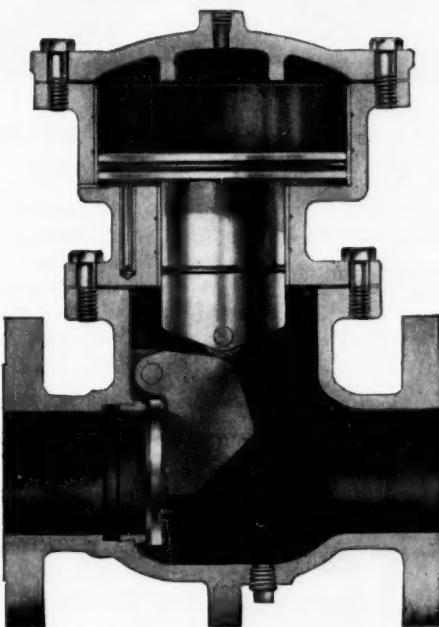
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These valves remain closed until manually reset. They are extremely popular in the chemical, petroleum and gas industry.

The piston type valve opens instantly. Opening and closing of this valve may be from any remote location — either automatically or manually. It is ideal for deluge systems.

Sizes run from 1½" to 8".

To get a more detailed story on this remarkable line of Coppus Sentry Valves, use the coupon to ask for Bulletin 500. Coppus Engineering Corp., Worcester 2, Mass.



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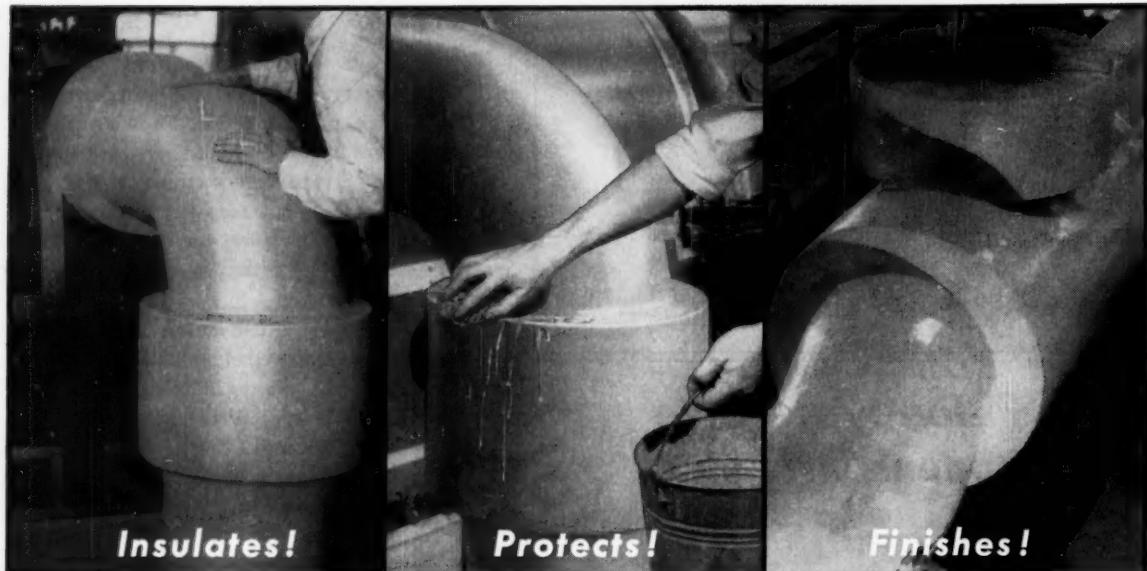
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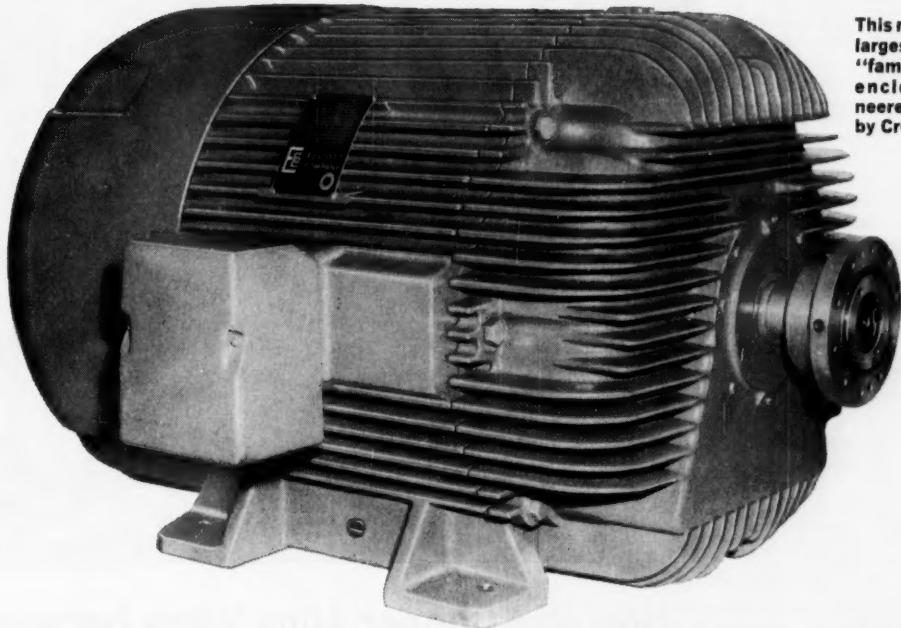


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ELLIOTT C-W SEALED POWER MOTORS

The numerous thin, deep ribs of Elliott C-W SEALEDPOWER Motors are the most advanced development of the ribbed construction, pioneered in the United States by Crocker-Wheeler. Modifications of SEALEDPOWER totally-enclosed fan-cooled motors include explosion-proof designs in all ratings up to 300 hp. Either open greasable or pre-lubricated bearings can be furnished.

Highly-effective sealing prevents entrance of moisture, dust, dirt, corrosive materials; consequently these motors can be depended upon for long, trouble-free service.

In numerous cases, SEALEDPOWER motors are proving to be more economical than standard open motors because of their low maintenance and dependability.

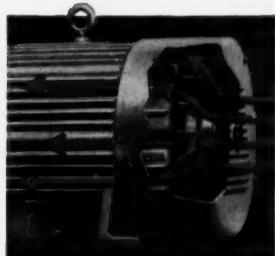
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JEANNETTE, PA.



Extra fins keep bearing cool. This potential trouble spot is effectively cooled by the generous extra fins seen in the photograph above.



Cooling blast hugs frame. Air is directed along fins extending entire motor length. Easy to clean — no enclosed cooling passages to clog up.



Newest data on modern enclosed motors—including explosion-proof—is given in Elliott Bulletin PB 6000-2. Send for free copy today.

W9-2

THE VALVE AND FITTINGS ANSWER CORNER



Send in your questions on stainless valves and fittings to Carl Tylka, Cooper Alloy Technical Service Director.

Q. What is meant by "ferroxyl quality" in evaluation of a stainless casting?

A. This means a superior surface quality free from pinholes, porosity, scale particles, iron film, grease, or other undesirable conditions, as is guaranteed by passing the ferroxyl test.

Q. Will stainless steel of the 18-8 type corrode in a moist atmosphere?

A. Not ordinarily, but it will in contact with graphite.

Q. Can the use of stainless materials having different hardnesses be effective in preventing galling?

A. Yes, providing the hardness differential amounts to 50 Brinell or more. Corrosion resistance of the hardened material is generally lowered, however, and trouble may ensue in severe service. Use of V2B alloy as the hardened medium will prevent galling and provide sufficient corrosion resistance.

Q. Is 18-8a MO (316) better than 18-8s (304) for use in hot strong nitric acid?

A. No, in this particular case 304 is better than 316.

Q. Why is it that steel is resistant to 70% sulfuric acid, while stainless 304 is not?

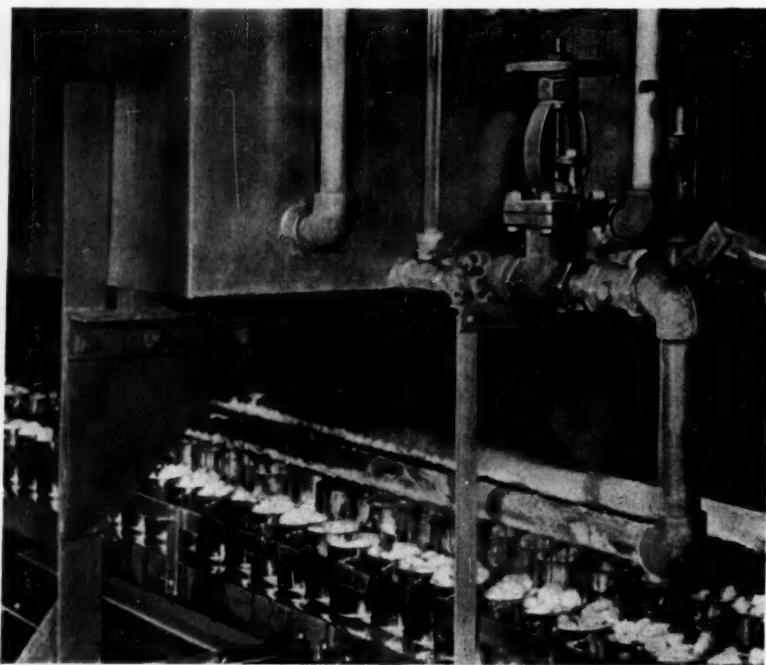
A. Because sulfuric acid forms an iron sulfate film on carbon steel which is insoluble in sulfuric acid of over 65% concentration, thus protecting the steel from further corrosion. This particular film does not form on stainless, which depends upon passivity for corrosion resistance. In 70% sulfuric acid passivity is lost and the stainless corrodes.

Q. Is 316 alloy better than 304 for handling hot caustic solutions?

A. No, 316 has no better resistance than 304 and FA-20. That is why Monel is recommended. In extremely severe cases use pure nickel.

Q. What can I use where 316 is necessary for corrosion resistance, but fails through lack of resistance to accompanying abrasion or erosion?

A. Cooper PH-55A alloy resists all corrosive media that can be handled by 316 (except very hot and strong nitric acid), and in addition is resistant to both abrasion and erosion.



How the Cooper Alloy Valve became a Giant—among Shrimps!

Cooper Alloy Valve Handles Hot Brine at Shrimp Canning Plant for Twelve Years Without Maintenance

It's not often that we get a chance to put a title as catchy as this on our valve success stories, but this story really rates it!

It all happened at the Robinson Canning Company in New Orleans, one of the world's largest canners of shrimp. They can as much as 100,000 lbs. of shrimp a day—three cans a second! And here's the problem: to the shrimp in each of these cans hot brine solution (180°F.) is added as a preservative—to the shrimps, that is, because brine is mightily corrosive to most valve materials.

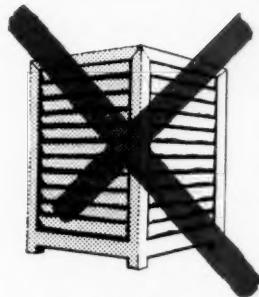
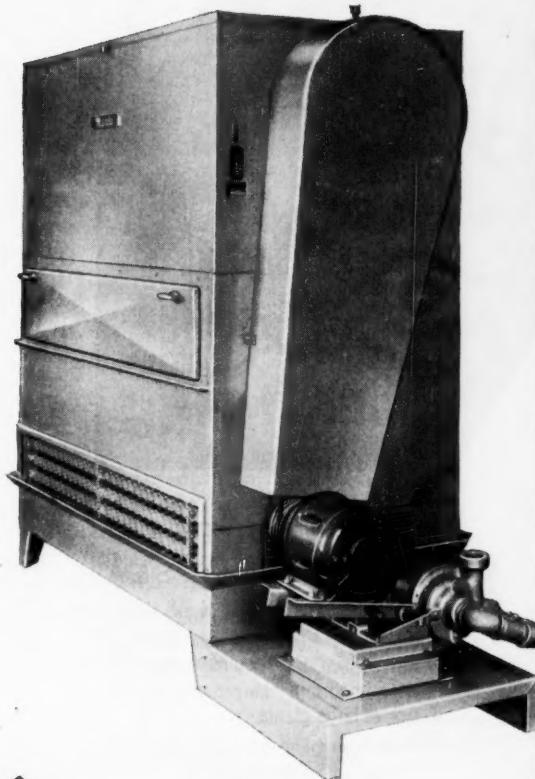
The master control valve for this gravity-feed brine-filling operation used to be a brass gate valve, but it couldn't stand the corrosion gaff. So, 12 years ago the Robinson people re-

placed it with a Cooper Alloy 1-in. Monel gate valve. (Vital statistics: OS&Y, 150-lb. service, bolted bonnet, screwed ends.)

And during the ensuing 12-year period, this Cooper Alloy valve has handled 2500 gallons of hot brine per day—without maintenance of any kind! Only very recently did it become necessary to replace a few non-Monel parts, such as handwheel, packing flange, and eyebolts.

As we said at the start of the story, that's a performance record that's a giant in any man's process! For more information on Cooper Alloy valves and their performance capabilities, write to Cooper Alloy Corporation, Hillside, N. J.

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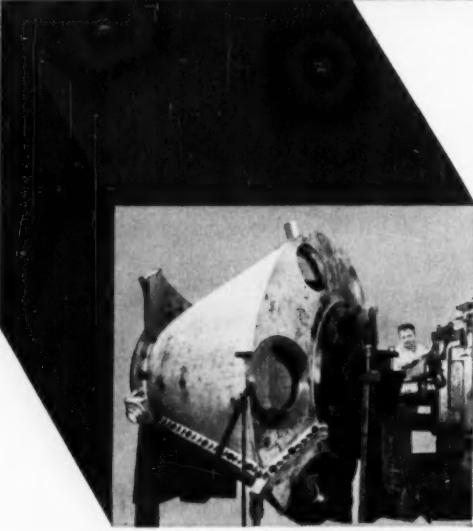
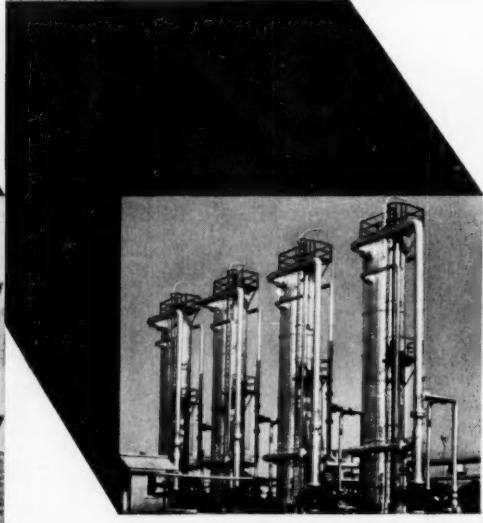
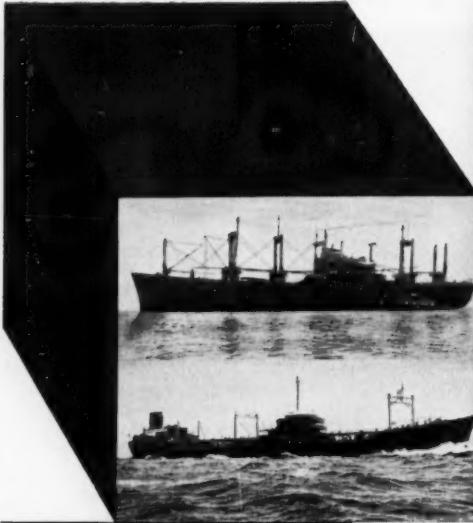
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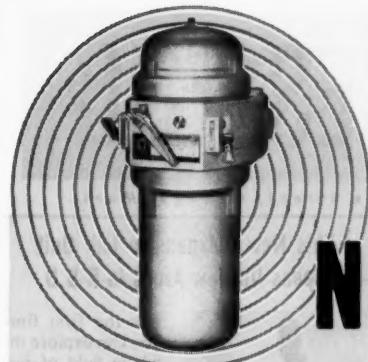
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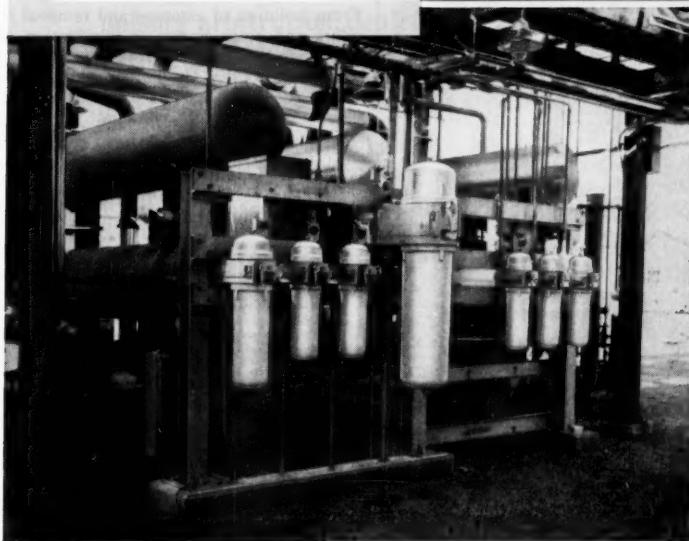


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...you now can order Square D Spin Top enclosed starters completely wired and mounted on racks built to your specifications. Or, working through our field organization, we'll help you or your engineers design the rack. Either way, all the wiring and assembly work is done at the factory. Rack framework can be either bolted and hot-dipped galvanized or welded and painted.



INSTALLING your Spin Top rack on the job is a breeze. Just bring in the feeder connections to the bus bars, and make the outgoing power connections from starters to motors. It's as simple as that! Square D's exclusive "slide and hook" mounting arrangement greatly simplifies starter inspection and maintenance.

Spin Top enclosures are available in four sizes to include circuit breakers, across-the-line starters and combination starters, Size 0 through 5, reversing, non-reversing, and two-speed versions. They're built for Class I, Group C and D; and Class II, Group E, F, and G service.

Write for details. Square D Company, 4041 North Richards Street, Milwaukee 12, Wisconsin



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RODNEY HUNT MACHINE CO., Process Equipment Division, 31 Vale Street, Orange, Mass.

RODNEY HUNT THIN-FILM TECHNIQUE SOLVES COMPLEX PROCESSING PROBLEMS

Manufacturers of chemicals, foods, pharmaceuticals and many other products have discovered in the Rodney Hunt mechanically aided thin-film processors a simplified solution to complex processing problems. Whether the process involves concentration, dehydration, heat transfer, stripping, deodorization, evaporation or reaction, these units assure closely controlled uniformity of product. They have proved to be particularly effective in processing time-at-temperature-sensitive materials because of short time exposure and minimum hold-up of fluids in the thermal section. The process is completed in one pass, continuously and rapidly, thereby eliminating the problems and downtime of conventional batch processing. Formation of crust or scale is minimized permitting operation for long periods of time without shutdown.

Broad Operating Range

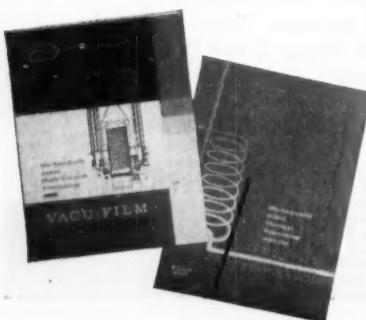
For processing at atmosphere and low vacuum ranges, Rodney Hunt offers the well known Mark II Turba-Film Processor. The new Vacu-Film Processor is designed for thin-film processing at high vacuum... to one-half micron. Installations of this new unit have resulted in higher and purer yields than ever before possible and have greatly simplified the thermal problem associated with high molecular weight materials. It has successfully isolated and purified complex pharmaceuticals which had been impossible to produce by conventional techniques.

Simplify Your Process

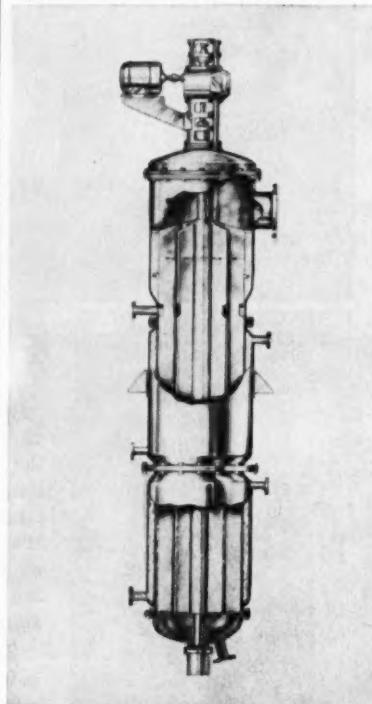
Rodney Hunt welcomes your specific requests for assistance in solving the most complex and unusual processing problems. A fully equipped laboratory and pilot plant staffed by experienced process engineers and technicians is available to work with you on your problem. Test results obtained from pilot size Turba-Film and Vacu-Film Processors can be readily extrapolated to production size units. If you prefer to do your own testing, portable units are available for purchase or rental.

Address your inquiry to the Rodney Hunt Process Equipment Division, 31 Vale Street, Orange, Mass. with details of your requirements. Detailed literature on the Turba-Film Processor and Vacu-Film Processor will be sent on request.

* * *



Turba-Film Processor



MECHANICALLY AIDED THERMAL PROCESSING

The Turba-Film Processor consists of a series of rotor blades operating within a thermal section and a separating section—all fabricated of alloy steel. Clearance between the rotor blade edges and the thermal section wall is exactly fixed to assure precise control of the film thickness. Vapor or gases pass upward through the thermal section to the separator from which entrained material is recycled to the thermal section. Steam, Dowtherm or other heating media is distributed in two or more compartments of the thermal section to assure a uniform temperature at the walls.

This New Inexpensive Lab Unit Opens Up New Areas In R & D



For the first time you can explore the whole field of mechanically aided high-vacuum processing at relatively low cost. The Rodney Hunt Laboratory Vacu-Film Processor is simple to operate... inexpensive to buy. It makes possible the

development of data in evaluating the application of high-vacuum techniques to a specific process in a commercial-size unit. It operates in a vacuum range from atmospheric to 1 micron Hg. at temperatures to 450°C. Continuous feed or batches from 10 ml to 20 litres. Temperature, product flow and rotor speed are easily regulated and controlled. Two or more units may be coupled for fractionation. All parts are readily accessible and can be quickly cleaned like laboratory glassware.

Many Areas of Application

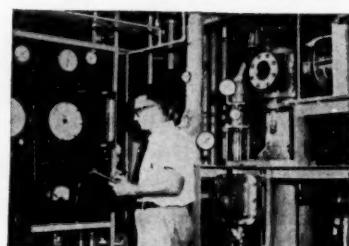
From isolation of essences and removal of odors and color bodies to purification of pharmaceuticals and distillation of fatty acids, the Rodney Hunt Laboratory Vacu-Film Processor uncovers many new applications of great profit potential.

Standard units (illustrated above) are now available for immediate shipment.

Price FOB Orange, Mass.—\$393.00

Descriptive Bulletin PE-108 sent on request.

Turba-Film Processor Solves Product Discoloration and Boosts Drug Yield



Abbott Laboratories encountered product discoloration and loss of product prior to placing the bacteria-killing drug ristocetin into full production. This problem was solved by replacing conventional evaporator with a Rodney Hunt Turba-Film Processor designed to handle the heat-sensitive product. The Turba-Film Processor helps turn out a uniform top-quality pharmaceutical product.

DEVELOPMENTS...

APRIL 20, 1959

Chementator

C. H. CHILTON

Stauffer has an improved titanium trichloride catalyst for polymerizing propylene, said to give severalfold increase in reaction rate.

Kellogg has won the first round in its legal fight with Monsanto and Heyden. New York Supreme Court decided in favor of Kellogg's request for compulsory arbitration, denied Monsanto-Heyden's opposite motion.

Firestone has quietly slipped into the nylon business. Company is polymerizing caprolactam and spinning filament on a developmental basis at its Pottstown (Pa.) plastics plant.

Phillips will use a "unique" reactor in a new alkylation unit at Kansas City. It will make better-quality alkylate at lower cost and with less investment, says the company.

Computer control runs refinery unit

Comment in our last issue (p. 72) that closed-loop computer control had not yet been applied to a commercial chemical process was out of date even before it got into print.

Texas Co. has just announced that its recently installed RW-300 digital computer-control system at Port Arthur, Tex., closed the loop about the middle of March. The Thompson-Ramo-Wooldridge equipment determines and actuates set-points for conventional pneumatic controllers on an 1,800-bbl./day polymer gasoline unit.

This unit was nearly 15 years old when Texaco decided to expand and modernize it by adding four reactors to the original six and by installing brand-new instrumentation. Decision to try computer control was based on these factors:

- Long experience had established a benchmark of what was best obtainable performance with conventional process control.

- Study showed that a yield of a minimum of 93% was attainable with optimum operation—contrasted with best historical yield of 85-87%, based on propylene content (about 30%) in cracking byproduct stream fed to process.

- Reactor shutdown and change of catalyst (phosphoric acid on kieselguhr) were expensive; closer temperature control would extend useful catalyst life.

Computer is more "watchful" than its human counterparts; it may detect an upset and correct for it even before the operator is aware of any abnormality. This keeps the process under closer control than when human operators are guiding it.

Cost of the venture is about \$300,000, with the computer and input-output equipment claiming about \$135,000 (the rest is for engineering and instrumentation). Payout will come from increased yield of polymer (valued at \$5/bbl. vs. the \$1.10/bbl. value of liquid propylene) and by cutting catalyst renewal cost. Texaco looks for "early" payout but also expects to benefit greatly from the experience acquired in this pioneering application.

NOW

a single **Condulet®** for all
make motor starter
and circuit breaker!



CROUSE-HINDS TYPES DMC* AND WMC** Combination Line Starter CONDULETS

DMC-WMC Condulets are designed to accept and operate any of the various makes of motor starters and circuit breakers. Single speed non-reversing combinations are equipped with a universal mounting plate, motor starter reset assembly and circuit breaker operating assembly. No substitutions of any parts on the Condulets are required.

Built-in push-button stations and selector switches with various contact arrangements, pilot lights and control transformers can be supplied. Push-button and selector-switch operating shaft holes and pilot-light holes may be drilled, tapped and plugged for future use.

Separate mounting lugs are bolted on body. A center position is provided on back of body so that lugs can be attached for 3 point suspension or center pole (2 point) mounting. Circuit breaker handle has provision for padlocking in "On" or "Off" position.

WRITE for descriptive literature and specifications . . .
or contact your Crouse-Hinds distributor.

CROUSE HINDS

MAIN OFFICE AND FACTORY: SYRACUSE, NEW YORK

Crouse-Hinds Company of Canada, Ltd., Toronto, Ont.

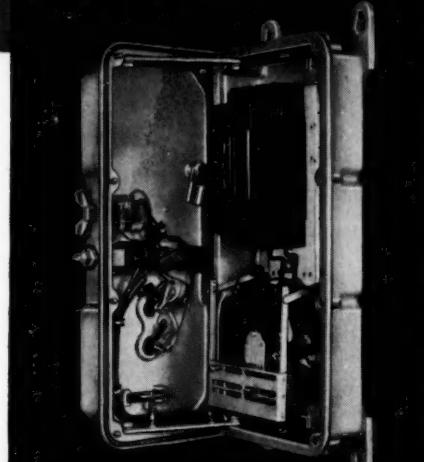
Crouse-Hinds Instrument Company, Inc., Silver Spring, Maryland

* CONDULET® ELECTRICAL EQUIPMENT (Explosion-Proof and Conventional) • FLOODLIGHTING
• TRAFFIC CONTROL SYSTEMS • AIRPORT LIGHTING and WEATHER MEASURING EQUIPMENT

These products are sold exclusively through electrical distributors. For application engineering help, contact one of the following offices: Atlanta Baton Rouge Birmingham Boston Buffalo Charlotte Chicago Cincinnati Cleveland Corpus Christi Dallas Denver Detroit Houston Indianapolis Kansas City Los Angeles Milwaukee New Orleans New York Omaha Philadelphia Pittsburgh Portland, Ore. St. Louis St. Paul Salt Lake City San Francisco Seattle Tulsa Washington Resident Representatives: Albany Baltimore Reading, Pa. Richmond, Va.

* TYPE DMC: Dust-Ignition-Proof (Dust-Tight) — National Electrical Code Class II, Groups E, F and G; NEMA Type 9EFG.

** TYPE WMC: Watertight — NEMA Types 3, 3R, 4 and 5.



UNIQUE COVER HINGING ARRANGEMENT allows DMC-WMC Condulets to be mounted directly adjacent to other Condulets without providing extra space between for cover to hinge open. Cover pulls out, then to either side to clear adjacently-mounted Condulets or other equipment.

Acrylic fiber spun with new solvent

Dimethyl sulfoxide, introduced by Stepan Chemical Co. a few years ago, now has its first volume use—as spinning solvent in production of acrylic fiber. Toyo Rayon Co., with plants in Osaka and Nagoya, Japan, has started full production of a new type of acrylic fiber, using DMSO as solvent.

Stepan had sold only 50-100 drum lots of DMSO until this new market opened up. The company is now making well over 1 million lb./yr. in new Chicago facilities and has its sights set for a 10-million-lb./yr. plant. Volume production is expected to lower current 34¢/lb. price to about 25¢.

A high-boiling (189 C.), water-white, nearly odorless liquid, dimethyl sulfoxide is bidding for other markets, too. These include: Antifreeze, paint remover, reaction medium, acetylene solvent (in acetylene cylinders, it holds 33% more acetylene than does acetone), selective solvent for fatty acids.

But use as acrylic fiber solvent, in addition to being its first commercial foothold, also appears to be DMSO's best hope for immediate growth. Several other Japanese manufacturers planning production of synthetic fibers are expected to use DMSO.

In this country, Du Pont has been looking into the possibilities of using DMSO, instead of dimethyl formamide, in production of Orlon. Chemstrand also expresses interest.

Moreover, a Japanese patent issued last year covers use of DMSO as a solvent for an acrylic fiber whose description resembles that of Dow's Zefran. Polyacrylonitrile is dissolved in DMSO, mixed with a solution of cellulose acetate in DMSO, and the fiber spun into a dilute DMSO bath.

Court evades Spevack-AEC issue

An individual chemical engineer has dared to defy the Atomic Energy Commission's broad powers—and won—in a case which attracted national attention among engineers.

In the case of Jerome S. Spevack vs. Lewis L. Strauss, et al., the U. S. Supreme Court decided on March 23 to continue an earlier injunction which prevents AEC from making public Spevack's invention of the dual-temperature heavy water process. The injunction will expire on issuance of the U. S. patent.

The Supreme Court decision came as something of an anticlimax. AEC, in its argument,

apparently retreated from its position taken in earlier court actions that it had the legal authority to publish a privately owned invention, disclosed in confidence, without consent of the owner. Thus the court was not obliged to rule on the statutory question.

Spevack has contended all along that AEC's move two years ago to publish his invention, as part of a general declassification program in heavy water technology, would jeopardize his ability to obtain foreign patent coverage and would thereby impair his property rights.

Spevack had been supported in this position in briefs filed by American Chemical Society and Engineers Joint Council as friends of the court. At the hearing last month the ACS attorney was given opportunity to speak for the chemical profession; unfortunately, EJC had no one on hand to speak for engineers.

Spevack's moral victory is tempered by the fact that the court decision requires him to pay the patent fee by May 25 so that the U. S. patent may issue shortly thereafter. He was denied continuance of the injunction if he sought for suspension or delay in issuance of the patent.

Plastics invade carbon-paper field

Like other staid old commodities before it, carbon paper is apparently yielding to the plastics age.

About a year ago Burroughs Corp. brought out a carbon-less "carbon" paper called Nu-Kote. Now Columbia Ribbon & Carbon Mfg. Co. has just introduced a similar product called Plastisol paper. In both products the conventional carbon-and-wax coating has been replaced with a longer-lasting plastic-and-ink mixture.

Columbia says its paper can be used 60 times, will save the user one-third to one-half his current carbon paper costs and will eventually displace conventional carbon paper except for specialized uses.

Paper is coated with a spongy vinyl film in which is dispersed an oil-based ink. Under pressure of a typewriter key, enough ink squeezes out to produce a clear, smudge-resistant copy. Company refers to this action as "liquid transfer," in contrast to the "solid transfer" action of carbon paper.

Since 1953 National Cash Register has

(Continued on page 76)



NEWS...catalyst for chemical progress

Without some medium of news, the discovery of a new chemical product or process would lead a quiet, unproductive life. News is the catalyst that turns a discovery into profit. This series of advertisements is intended to speed your reaction to new products and processes, shortening the time between their discovery and the day they can be put to profitable use in your own business.

You may wish to check certain items in this advertisement and forward to those concerned in your company.

ROUTE TO:

CHEMICAL 'COOK' ELIMINATES PROCESSING FAILURES

The danger of direct fire and the enormous pressures of steam have made high temperature processing by either of these methods uncertain . . . often times unsafe. Dowtherm® A, organic heat-transfer medium, keeps a steady hand on high temperature control, while reducing fire hazard and cutting pressures to as much as one-thirtieth that of steam.

The automatic electric frying pan may have made the "processing" of such a thing as a fried egg practically foolproof. But in industrial high temperature processing, heat control still is a problem in many plants where pinpoint accuracy is vital to the uniform quality of the finished product.

From potato chips to automobile parts, these products have traditionally been processed using direct fire or steam. Each system has had inherent drawbacks, . . . the potential hazard of fire or the high cost of equipment to

handle steam at high pressures. And neither has been notably satisfactory in making it easy to keep temperature gauges from wavering.

Safe, steady heat is now a reality, however, with the use of Dowtherm A as a vapor phase heat-transfer medium. This "thermostat" chemical is highly stable, permitting processors to maintain temperatures with fraction-of-a-degree accuracy between 350°F. and 750°F. And this accurate heat can be supplied to several processing units at different temperatures if desired. Be-



Equipment for the use of Dowtherm A often pays for itself in three to five years through reduced costs and improved production.

cause the heat source for systems using Dowtherm A can be located at a safe distance from the actual processing operation, the danger of fire is greatly reduced.

Contrasted to the heavy, high cost equipment necessary to contain 700° steam under more than 3,000 pounds pressure, Dowtherm A at the same temperature takes light handling because it exerts only 110 pounds pressure per square inch.

The singular attraction of Dowtherm A as an unequaled medium for precision heat transfer has led hundreds of processors to install new or modified equipment to handle the chemical. But then other dividends accrued, too. These processors have found that systems using Dowtherm A were actually self-liquidating in three to five years time through reduced insurance rates, decreased operating and maintenance costs, improved production.

Dowtherm A has been used for more than 10 years with outstanding success to mold plastics and rubber products, distill fatty acids, process paints and varnishes, manufacture linoleum and in a wide variety of other applications in food processing, chemical processing and metal plating.

Special Dowtherm products now have been developed for profitable new uses. Examples are Dowtherm SR-1 for subsurface snow removal systems and Dowtherm 209, a freeze point depressant for ebullient cooling.

* * * *

If you aren't already profiting from these and other Dow chemicals, we suggest you write for complete information to THE DOW CHEMICAL COMPANY, Midland, Michigan, Chemicals Sales Department 911AK4-20.

METHOCOL:

These gums stretch over widest viscosity range

Versatile, synthetic gums are expanding into new areas of textiles, paper, food and paint manufacture. And a big reason for this expansion has been the wide usefulness of Dow's family of synthetic gums with the widest viscosity range . . . the Methocel® products.



60-page Methocel Book describes properties and uses of versatile synthetic gums.

With available viscosities ranging from 10 cps. to 15,000 cps., Methocel gums have shown exceptional capabilities as thickeners, stabilizers, film formers, emulsifiers, suspending agents and binders.

These water-soluble, nonionic gums have a profitable performance record in improving products and processes . . . from basic viscosity control to conquering such complex problems as suspension polymerization. It takes no stretch of the imagination to discover their potential usefulness in your business. A close look at the most recent 60-page book on Methocel products will show you.

One-stop shopping for POLYOLS

In the colossus of the modern department store, you'll see occasionally a sign which says something to the effect, "If you can't find what you're looking for . . . just ask for it".

The chemist or processor looking for the right polyols for his own particular application will find the same assurance of supply in the Dow inventory of these basic chemicals, accurately labeled "world's widest line of polyols".

This amounts to more than just purchasing convenience, however. It means the men at Dow have much to offer the polyol user, too, in the way of technical service, research information and new polyol products for experimental use as intermediates, plasticizers, emulsifiers, lubricants, antifoamers, coolants, solvents and other products.

DOW CHEMICALS basic to the chemical processing industry

Alkylene Oxides, Glycols
Industrial Preservatives • Glycol Ethers
Polyalkylene Glycols • Alkalies
Phenolic Compounds • Brominated and Chlorinated Aliphatic Compounds
Inorganic Acids • Halogens
Organic Acids and Esters
Inorganic Chlorides, Bromides and Bromates • Nitrogen Compounds
Amino Acids • Glycerine • Salicylates
Phenyl Phosphates • Chelating Agents
Flotation and Flocculating Agents
Heat-Transfer Media • Methylcellulose
Ion Exchange Resins • Magnesium
Plastics • Aromatics

THE DOW CHEMICAL COMPANY
Midland, Michigan



DOW CHEMICALS . . . well worth noting



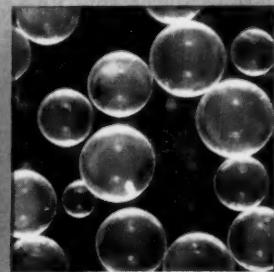
PHARMACEUTICALS

Dow supplies imposing list of pure, high quality pharmaceutical chemicals such as bromine, medicinal salicylates, epsom salt, chloroform, analgesic drugs, elemental iodine.



SEPARAN

Separan® NP10 and Separan NP20 flocculating agents achieve over-all plant economies through rapid, efficient settling of solids from processing water.



ION EXCHANGE RESINS

Dowex® 50W, white cation resin with excellent bead strength and uniformity, is newest member of Dowex products for many industrial processing applications.



BROMINE

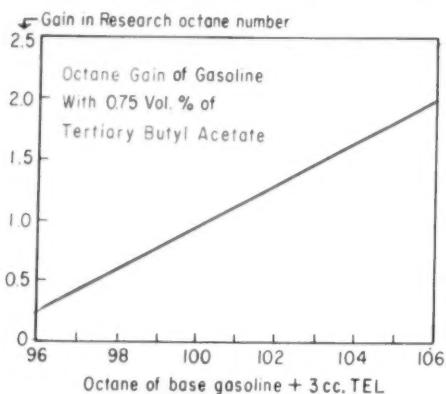
Most grades of bromine and brominated products are available from Dow where nearly 70 years of leadership in research, know-how and production are at your disposal.

been on the market with a product which does away with either kind of transfer altogether. Called NCR ("no carbon required"), it consists of treated paper, one side of which is covered with microscopic capsules containing color-reactive liquids. The other side (or a second sheet of paper which faces the first in the typewriter) contains an activated clay with acidic properties. When pressure from a typewriter key breaks some of the capsules, chemicals from the two coatings react to produce color.

Encapsulated chemicals are colorless lactones of various triphenyl methane dyes. Transfer of electrons from the lactone to the clay permits rearrangement of the molecule into the colored quinoid form.

Eventually National Cash Register hopes to put both capsule and clay coatings on the same side of the sheet. With such a product there would be no need for even the typewriter (or cash register) ribbon.

New additive boosts octane ratings



Texas Co. disclosed late in March that its researchers had turned up a new antiknock agent for gasoline which company officials proudly hailed as "the most important development in the antiknock field since the introduction of tetraethyl lead 36 years ago." It will be made available to the entire industry via "appropriate licensing procedures."

Chemically, the new additive is tertiary butyl acetate. Alone, it has no beneficial effect on octane rating. But added to gasolines containing up to the legal maximum (3 cc./gal.) of TEL, TBA will boost the leaded octane rating. Texaco thus calls the additive TLA for "Texaco lead appreciator."

As shown in the graph, TBA's effectiveness increases as octane rating of the base

fuel goes up. Addition of TBA thus is worthwhile only for today's premium and super motor fuels.

What will refiners have to pay for octane gain via TBA? Based on Texaco's figure of 0.75% by volume, approximately 0.07 lb. TBA is needed per gal. The chemical is not now commercially made, but similar chemicals sell in the 12-18¢/lb. range. Thus the refiner may have to figure on roughly 1¢/gal.

However, Texaco hints that it has a simple process for making TBA (reaction of low-cost isobutylene with acetic acid) which would be available to a prospective manufacturer of the additive.

Whether or not a refiner finds TBA economical will depend on his particular situation. If he needs additional octane for premium gasolines and faces the harsh prospect of putting in costly new process equipment, adding TBA might turn out to be cheaper. Texaco itself does not plan early use of TBA because its refineries can meet present octane demands without new plant additions.

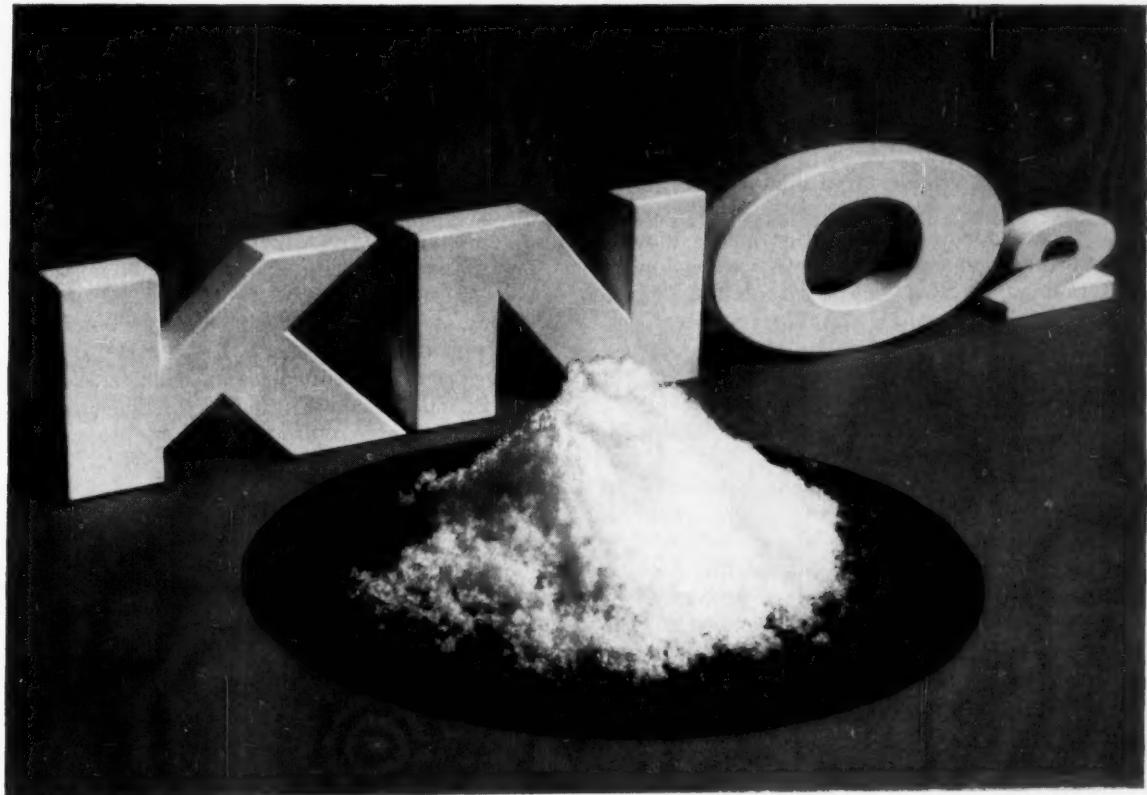
Just a year ago (*Chementator*, May 19, p. 60) Ethyl Corp. announced a new antiknock agent, AK-33X, containing manganese. Its performance and suggested cost were apparently even more attractive than those of TBA, yet no commercial use has developed so far.

Ti plus Pt equals better electrodes

Producers of caustic-chlorine and other electrochemicals have a new advance in technology to evaluate—platinized titanium electrodes. Imperial Chemical Industries in Britain and Ionics, Inc., Cambridge, Mass., have independently turned up similar materials.

Ionics' development, called Tirrelloy, is an outgrowth of Ionics' work in the field of electrodialysis of salt and brackish waters. Tirrelloy anodes are being used now in some 30 Ionics demineralizers. Prior to its development, says Ionics, no anode material was available which successfully combined adequate corrosion resistance, good electrochemical properties and modest cost.

Tirrelloy anodes have a thin film (5-50 microinches) of a precious metal (usually platinum) chemically bonded to a base metal, such as titanium, columbium or tantalum. Ionics won't talk about the bonding process except to point out that it is neither a mechanical nor an electrolytic technique.



Have you a spot for potassium nitrite?

You can now obtain high purity potassium nitrite in carloads or truckloads from B&A®.

Perhaps its properties may meet a special requirement you've been trying to fill. Or you may want to apply it as others have—as a heat exchange medium or as a corrosion inhibitor.

Baker & Adamson offers two grades of potassium nitrite: Crystal Technical, in 200 lb. polyethylene-lined steel drums . . . Crystal Reagent, in 100 lb. polyethylene-lined drums.

Mail coupon for technical data, samples.



GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N. Y.

Physical and Chemical Properties:

Appearance white to cream-colored
deliquescent small crystals

Molecular Weight 85.11

Melting Point 297°C

Decomposition starts slightly above the melting point.

Solubility: Very soluble in water and ammonium hydroxide;
slightly soluble in alcohol.



Baker & Adamson® Fine Chemicals

GENERAL CHEMICAL DIVISION

ALLIED CHEMICAL CORPORATION

40 Rector Street, New York 6, N. Y.

Please send: Technical data Samples

Name _____

Title _____

Company _____

Address _____

City _____ Zone _____ State _____ CE 20

Two chlorine producers are now evaluating Tirrelloy anodes as a possible replacement for graphite. Tirrelloy's higher first cost, hopes Ionics, will be more than compensated for by reduced power consumption as the result of lower voltage drop. And less anode "wear" during cell operation makes it easier to maintain close control over the all-important gap between anode and cathode, claims ICI, Britain's major titanium producer.

Other potential uses:

- As a nonconsumable anode for impressed-current cathodic protection against corrosion. This use is now being evaluated by a Navy installation.

- As a corrosion-resistant material of construction for chemical services where titanium itself is unsuitable.

- As anodes for electroplating, electro-descaling and electrophoresis operations.

In a closely related development, Union Carbide has just come out with an alloy of titanium with a noble metal (e.g., 0.1% of platinum or palladium) which is resistant to some boiling solutions of reducing acids.

Tomorrow's Technology

Today's embryonic developments which have special significance for chemical engineers

Wanted: New supersonic jet fuels

As jet planes fly faster and faster, temperatures aboard get higher and higher. Air Force would like to use the jet fuel, before burning, as a cooling agent for parts of the airplane that would otherwise get too hot at high speeds. Problem is that such petroleum fuels as JP-4 begin to crack or break down into coke before they reach the combustion chamber.

Under prodding by Wright Air Development Center, chemical and petroleum producers are looking for fuels with greater thermal stability. Air Force would like to get a fuel stable to 700-800 F., with heating value of at least 18,400 Btu./lb. and 135,000 Btu./gal. At AIChE's Atlantic City meeting last month and ACS's Boston meeting this month, chemists and engineers presented papers and exchanged ideas on how best to meet this challenge.

Research data so far indicate that carefully refined aliphatic petroleum fractions or

saturated cyclic hydrocarbons may be suitable. Unsaturated compounds (olefins and aromatics) are taboo. Koppers Co. nominates hydrogenated creosote and decalin (made by hydrogenating naphthalene) as likely candidates.

Potential military market is estimated at 2-3 million bbl./yr. Although much smaller in size than the market for JP-4 (over 100 million bbl./yr.), market for the special new fuels may amount to substantial dollar volume because of their probable high cost. Estimates of price range from 2½ to 10 times as much as JP-4's 10-12¢/gal. This kind of business may be more interesting to coal-tar-chemical producers.

Plastic foams up in the air

Foamed plastic smoke is our nomination for the most unusual development reported at this month's ACS meeting in Boston.

The new smoke is an air-borne suspension of tiny particles of expanded cellular polymer which have a density of 0.1 gm./cc., compared with about 2 gm./cc. for ordinary smoke particles. Urethanes and phenolics are among the resins successfully smoke-foamed—or foam-smoked—via a technique developed by Betty Lou Raskin at Johns Hopkins.

No research on commercial or military applications of foamed plastic smokes has been done yet, but the Air Force, for one, would like it encouraged. Potential civilian uses: as an insecticide carrier and as a replacement for frost-protecting smudge pots.

Among other polymer developments disclosed at the ACS meeting:

- Mobay has a new water-based baked polyurea coating based on isocyanates and amine-bearing resins. To incorporate water and isocyanate in the same system without causing an immediate reaction is quite a trick. To do this, Mobay uses a blocking agent which is driven off with the water when the coating is baked. Coatings, applied directly to metal, form an excellent bond and are highly corrosion-resistant.

- S. C. Johnson reported new coating materials based on its recently announced diphenolic acid. These new resinous film-formers are made by reacting DPA with vegetable oil derivatives, such as epoxidized fatty acid esters. Air-drying co-esters have been made by reacting DPA with a soya-type refined fatty acid and pentaerythritol.

For more on DEVELOPMENTS.....80

ECO

ENGINEERING

NEWS

the big name in small pumps for the process industries

Pumping Notes

Handling Distilled and Deionized Water

Thousands of Eco ALL-CHEM^x Pumps are in use in many industries protecting distilled and deionized water from contamination. Their stainless steel and TEFLO construction and lubricant-free operation insure this protection from a chemical standpoint. Further, their non-shearing, smooth, positive thrust of two opposed impellers with overlapping strokes, provides linear, non-foaming flow. This is most important in applications where entrained air bubbles would cause imperfect product results.

Typical applications of this unique, positive-displacement, rotary pump are in handling distilled and deionized water for ampule washing in the pharmaceutical field, washing of germanium diodes in the electronics field, processing of black and white and color film in the photographic field. In national defense, they are also pumping distilled cooling wafer to the large electron tubes used in the "Dew-line" radar installations across America.

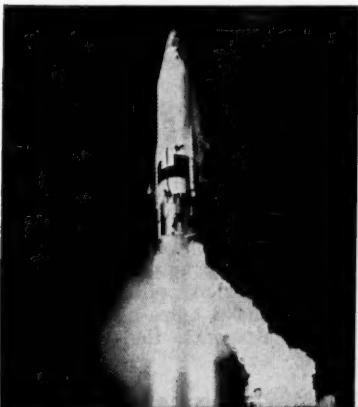
"Missile Grade Accuracy" at Production Prices

March ninth issue of American Machinist carries a two page advertisement of leading machine tool builder, Warner & Swasey, featuring Eco's automatic machining of pump parts from extremely difficult-to-machine nickel alloys and austenitic stainless steels, "with missile grade accuracy" (tolerances as low as ".0005"), and at production rates 3 to 10 times faster than previous methods.

"Missile grade accuracy," of course, refers to Eco All-Chem pumping units used in rocket fueling at Cape Canaveral.

But of even greater significance is the W & S statement that "for the first time, the chemical process industry has a wide selection of standard stock pumps at production prices to replace former, high cost custom-built units."

Thank you, Warner & Swasey, for telling our story so well, and for your fine automatic machine tools that have made it possible.



NEW ZIRCONIUM PUMP



Handles Boiling HCl

The first commercial-priced production-run zirconium pumps, made from a hitherto rare A.E.C.-developed alloy, are now available for pumping high temperature acids above the range satisfactorily served by Hastelloy C.

Applied initially to the $\frac{3}{4}$ " port, Series 400 Eco GEARCHEM^x Pump with flows to 10 gpm, this pump is the only rotary, positive displacement pump for HCl service, machined to close tolerances and providing reproducible metering accuracy within $\pm 1\%$. All other pumps offered for such service up to this time have been centrifugals or pulse-type proportioning pumps.

High Mechanical Reliability

The decision to explore the possibilities of zirconium as a metal for hot acids was made after careful consideration of all other materials in commercial use.

Ceramics and glass were ruled out because they were subject to thermal and mechanical shock, contributing to unreliability and short life.

Rubber was considered but its temperature limitations caused progressive hardening and chemical deterioration above 140°F. Fluorocarbon linings showed embrittlement under flexing and proved unsatisfactory for the purpose.

And, of course, the Hastelloys^{*} were considered. Hastelloy C, while machinable, was not sufficiently resistant to hydrochloric above 120° F., and the other Hastelloys were either impossible or too difficult to machine on the high speed, automatic, precision machine tools used by Eco in mass production of their pumps.

The new commercial zirconium alloy containing 2.5 hafnium, though a much more expensive raw material, was experimented with and found to have characteristics favorable to automatic tooling and mass production methods which largely overcame its higher original material cost.

Advantages to Chemical Plant Operators

Zirconium GEARCHEM Pumps exhibit zero effects of corrosive attack when exposed to boiling hydrochloric acid, permitting their use without contamination of the pumped acid with metallic salts, as is experienced through the progressive dissolution of other corrosion affected alloys and non-metallics.

Zirconium is also equally immune to the effects of hot nitric acid at all concentrations, alkali solutions, fused caustics and organic compounds, and is fully resistant to boiling sulphuric acid at concentrations up to 70% and phosphoric acid up to 60%.

Being a durable metal, zirconium is subject to none of the problems of brittle and thermal-shock-sensitive materials.

The result is the most mechanically and chemically reliable pump with greatly extended useful life—making it the most economical pump commercially available for hot acid service. These zirconium GEARCHEM Pumps are regularly furnished with chemically impervious gears of du Pont TEFLO[†] (another contemporary A.E.C. sponsored development), and with zirconium gears, on special order. Pumps feature a grease-sealed stuffing box to insure leakproof operation against pressure or vacuum, in open or closed loop systems.

ECO Products for Handling Corrosive and Hazardous Processing Fluids

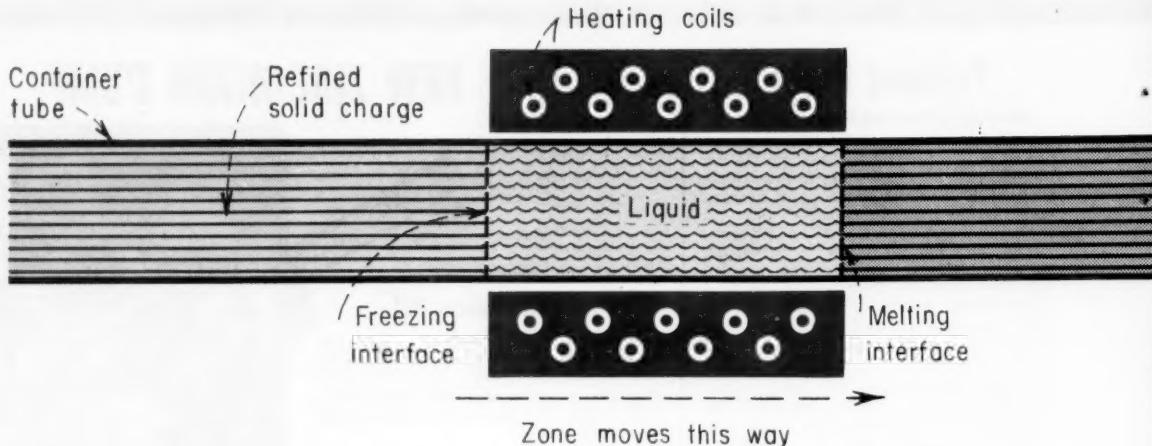
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MINILAB Rotary Pumps
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CENTRI-CHEM Centrifugal Pumps
PUMPMOBILE Portable Pumping Units
CHEMICAL FAUCETS Factory Mutual Approved

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Zone Refining Excites Hopes for

Now used widely for purifying semi-conductors, zone refining captures the imagination of chemical people, may lead to new product-purity levels.

Basic contributor to semiconductor's fabulous growth, zone refining may have an even bigger future in purifying and separating other types of materials.

Says one top metallurgist, "Zone refining eventually should find its widest use in the chemical industry."

And says the technique's inventor, William G. Pfann of Bell Telephone Laboratories, "The possibilities for tonnage production are attractive in the chemical field, as many chemicals have reasonable melting points, thermal conductivities and low reactivity."^{*}

► Reaches Unusual Purity — Magic combination offered by zone refining is simplicity plus

spectacular effectiveness with favored materials. Purities it attains for semi-conductor metals are at the parts-per-billion level.

To be sure, the semi-conductor field has had a specific, immediate, commercial need for these incredible purities. But the whole trend in modern technology is in the same direction.

For high purity, pharmaceutical and other chemical industries lean heavily on fractional crystallization which shares zone melting's basic principle: A freezing crystal differs in composition from its liquid.

Zone melting adds the idea of melting part, rather than all, of charge at a given time. And by gradual movement of the molten zone through the solid

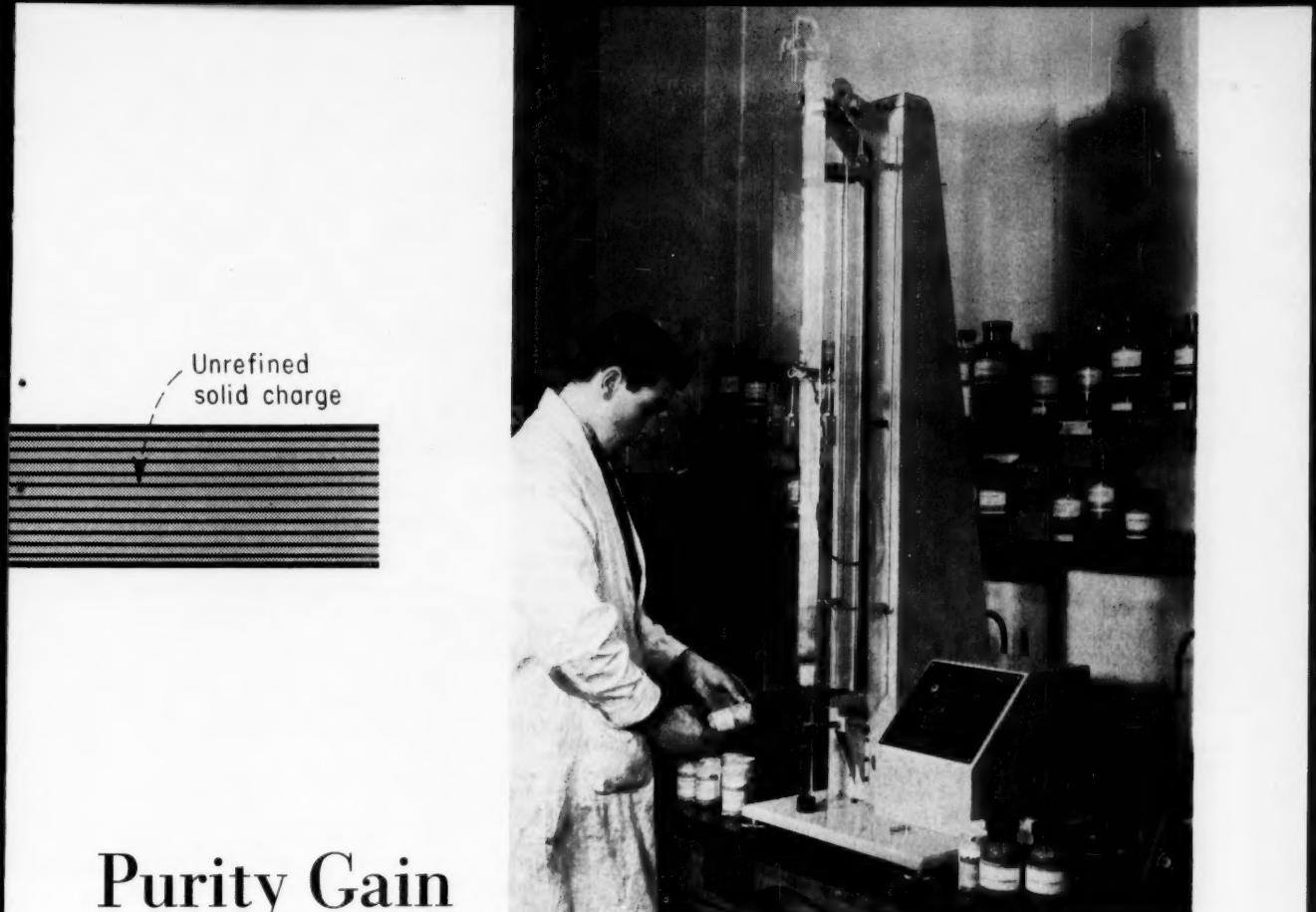
charge, this technique segregates the impurities.

► Commercial Evidence — Backstage, there's activity aplenty bent on harnessing zone refining's broad possibilities to chemical processing. That's borne out by a flood of research papers and interested comment. And already, commercial activity has started on a small scale.

Laying claim to the first commercial zone refiner is a \$545 unit for nonmetallics introduced by Fisher Scientific last year. Admittedly small, the unit automatically purifies 1- to 55-ml. charge of either organic or inorganic solids melting between 50 and 300 C.

Fisher's chemical manufacturing division will use the unit to make extra-high-grade organic reagents. Considerable

* Pfann, W. G., "Zone Melting," John Wiley & Sons, 1958



BENZOIC acid undergoes bench-scale refining at Hopkins & Williams, Ltd.

Purity Gain

manufacturing experience has been gained on benzoic acid, acetanilid, naphthalene, vanillin and anthracene.

In England, zone melting apparatus sold by Baird & Tatlock (London) Ltd., will purify about one kilogram of organic solids. An associated company, Hopkins & Williams, Ltd., sells benzoic acid purified for volumetric standardization in Baird's zone melting unit.

Also, L. Light & Co., Ltd., is selling zone-refined organics. Light is particularly interested in growing scintillator crystals from zone-refined polyphenyls such as anthracene, stilbene and terphenyl. Company also removes water and other impurities from dioxane rendering it suitable for spectroscopic purposes.

Anderson Physical Laboratory, Champaign, Ill., hopes shortly to produce ultra-pure alkali halides commercially by a combination of zone refining and other purification techniques.

► **More to Come**—Typical of difficulties that zone melting overcomes are refining of indole, 3-methylpyridine and 9-methylcarbazole to 99.9% purity. Carried out by Bureau of Mines investigators at Laramie, Wyo., zone refining of these chemicals bypassed difficult high-temperature distillations, complicated in one case by impurities boiling close to the product boiling point.

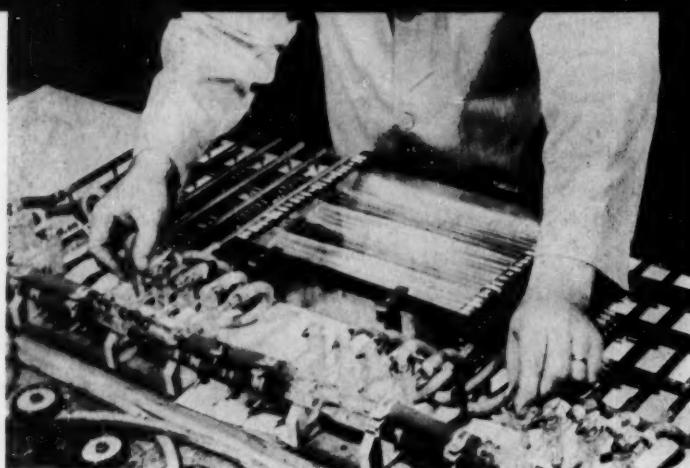
For several years, Battelle Memorial Institute has worked extensively on zone refining of metals, intermetallic compounds,

organic and inorganic compounds for government and industry. But only its work on zone-freezing of sea water to produce fresh water can be identified by name at present.

Companies such as Koppers, Merck and many others are experimenting with zone refining of aromatics and pharmaceuticals.

At Natick, Mass., the U. S. Army Quartermaster Research & Engineering Command is working on fractionation of polymers on a molecular-weight basis from frozen charges of polystyrene in benzene.

Nonmetallic elements such as tellurium, arsenic and silicon have undergone successful zone refining, as have intermetallic compounds such as indium, gallium and aluminum in combina-



MULTISTAGE, flat-bed refiner improves purification of low-melting wax.

tion with antimony, arsenic and phosphorus.

► **Where It Fits**—In general, zone melting is useful for any melted crystals not sensitive to heat whose impurities tend to concentrate in either the solid or the liquid from which it crystallizes.

However, the technique cannot be applied to all organics. Certain difficulties arise as molecular size increases: Poor mixing due to higher viscosity, slowdown in nucleation and lack of a sharp transition from solid to liquid.

But, work such as that of the U.S. Army group noted above and work reported in England (Peaker, F. W. and Robb, J. C., *Nature*, 182, 1591, Dec. 6, 1958) promises better future success on such materials.

Heat sensitivity of pharmaceutical compounds is a particularly frequent barrier to use of zone melting in the drug industry. One way to lick this problem is to crystallize from solvents rather than from melts. And in the case of liquid compounds, cooling to the freezing point permits use of zone melting.

► **How Zone Melting Works**—Simple, batch, zone refining passes a molten zone along a solid bar. As zone advances, material melts at one interface and solidifies at the other.

If impurity in the material lowers the melting point, the freezing-to-liquid interface will constantly reject molecules of the impurity. Gathering in the molten zone, these molecules move with zone to end of bar leaving purified material behind.

If impurity raises the melting point, its molecules will deposit at the freezing interface so that bar becomes progressively purer in the direction of zone movement.

► **Simple Equipment**—Commonest zone melting apparatus holds solid bar in a boat container or glass tube. Movable heating coils encircling container produce melted zone and move it along bar.

Whereas, most zone melting used currently is multistage batch type, Pfann has devised several ingenious ways to speed up operation and make it continuous.

For example, the experimental device shown above improves the purification of low-melting wax. A bed of material lies over closely spaced banks of pipes. Alternate heating and cooling of pipes keeps a number of zones working simultaneously on the material.

For continuous refining, apparatus must accommodate material flow as well as zone movement. Several of Pfann's methods divide entering feed into flow through two column sections, withdrawing pure product and waste stream at different points.

► **Much to Do**—Zone melting has barely begun to stretch its muscles to accommodate various conditions. In his new book, Pfann comments, "Little effort has been made to achieve high efficiency and speed by close spacing of zones and forced agitation of the liquid. . . . Although in its simplest form, zone refining has been highly successful in purifying certain materials, it requires additional

pains to purify materials having unfavorable distribution coefficients or very low thermal conductivity, or high chemical reactivity . . . such limitations . . . should be lessened as familiarity with the method increases."

New U-Fuel Plant to Use Fluid-Bed Processing

Britain's new \$36-million uranium processing and fuel plant at Springfield, Lancashire, applies the concepts of continuous processing to uranium chemistry that has been evolving over the past 15 years. Equipment such as screw conveyors and continuous filters give a degree of process continuity not found in any similar U. S. fuel plant, it is said.

But the most radical departure from conventional technology is yet to come. By 1960, the plant will have three fluid-bed columns in operation for producing UF₆. Uranyl nitrate from solvent extraction will be oxidized with air to UO₃ in the first column, reduced with hydrogen to UO₂ in the second, and fluorinated with HF in the third column. The UF₆ will then be reduced to metal with magnesium by conventional methods.

U. S. researchers have looked into the problems of fluid-bed uranium processing and the UF₆ plant at Paducah, Ky., employs a fluid-bed reduction of UO₃ to UO₂ with hydrogen (*Chem. Eng.*, Mar. 23, 1959, pp. 140-143). But U. S. engineers have felt that fluorination step is not suitable for fluid-bed processing; the problems are outlined in Paper A/CONF.15/P/525 given at Geneva. But evidently the British feel they have licked the problems involved.

Capacity of the new British plant has not been revealed, but is believed in excess of 2 million lb./yr. This is roughly twice the size of this country's largest privately owned facility—Davison's plant at Erwin, Tenn. (*Chem. Eng.*, Oct. 20, 1958, pp. 138-141). Chemistry of the processes in the new British plant is quite similar to that used in the Davison unit.

CORROSION RESISTANT

2-way valves (requiring separate source operating pressure)

ASCO offers a complete selection of corrosion-resistant 2 and 3-way solenoid valves.

ASCO is the single source for a complete selection of Solenoid Valves capable of controlling corrosive gases and liquids.

Fully automatic or manual reset 2 and 3-way valves are available; 2-way valves can be obtained which are suitable for operating with or without a separate pressure source. Pipe sizes range from 1/8" to 6"; pressures to 1500 PSI, temperatures to 600°F. Catalog listed body materials include, for example, cast iron (with nickel alloy trim), cast steel (with stainless steel

ASCO CATALOG SIMPLIFIES SELECTION OF 2 AND 3-WAY CORROSION-RESISTANT VALVES

trim), stainless steel and monel – with rubber or glass linings. Many other types of body and trim material are available – or special valves can be designed to your specific application. All valves are available with standard, watertight or explosion proof solenoid enclosures, to meet any installation requirement.

Fluids handled range from sulfuric acid to sodium hydroxide — and include a variety of materials such as vegetable oils, distilled water, acetylene, coke oven gas, etc.

All of these basic types of valve operation are available from ASCO.



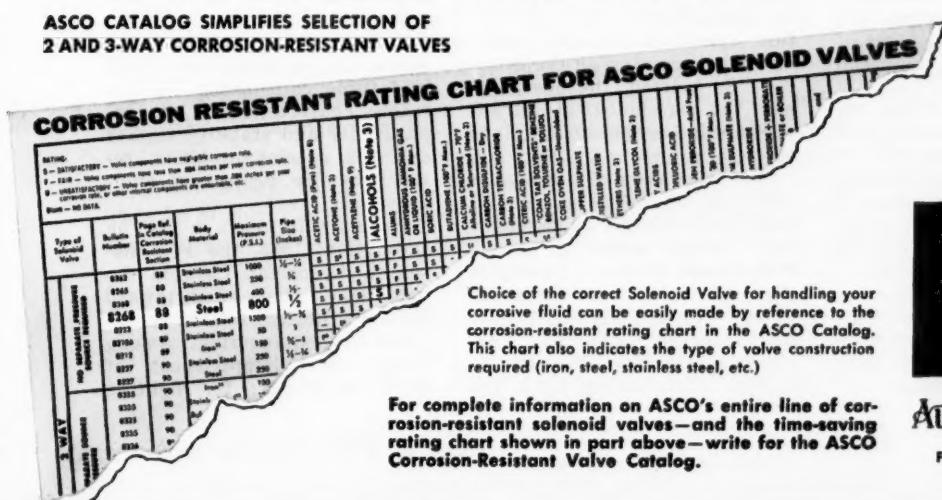
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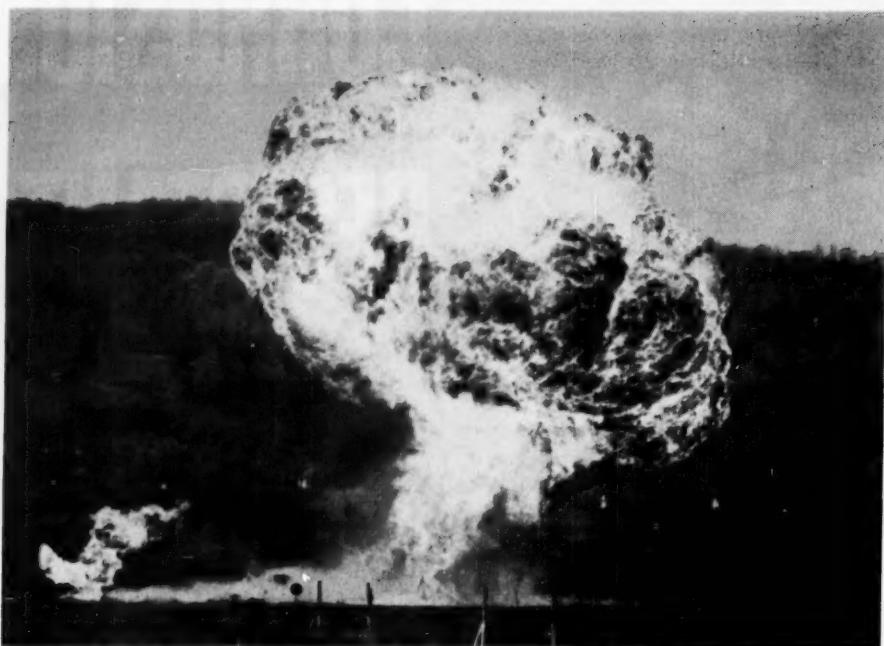


Choice of the correct Solenoid Valve for handling your corrosive fluid can be easily made by reference to the corrosion-resistant rating chart in the ASCO Catalog. This chart also indicates the type of valve construction required (iron, steel, stainless steel, etc.).

For complete information on ASCO's entire line of corrosion-resistant solenoid valves—and the time-saving rating chart shown in part above—write for the **ASCO Corrosion-Resistant Valve Catalog.**

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FIREBALL from research trial leads to safe production and handling of reactive chemical.

Fire Research Pays Process Dividends

With their own special talents, fire researchers at Union Carbide Chemicals Co. now reduce in-process hazards and boost production efficiency.

Fires such as that pictured above are teaching engineers how to control today's reactive chemicals through all stages of manufacture, shipping and end use.

Here we see test of the explosibility of ethylene mixture with diluent. Carried out by engineers at Union Carbide Chemicals Co.'s fire research laboratory, test data led to increased output of a given product from existing equipment.

Other recent work with a pyrophoric material enabled Carbide to operate new unit producing material for more than a year without mishap.

While developing data on this reactive chemical, Carbide's fire researchers carried production operators through familiarization training on the material. So briefed, the operators had the psychological advantage needed to operate the plant safely.

But prevention of disaster is only one of the gains coming from such studies at Carbide's fire research center.

► **Emphasis Shifts** — Examples such as these from Carbide's recent studies highlight how fire protection is changing. Formerly a defensive function, it is now contributing basic im-

provement to process and equipment design as well as to operating procedures.

Work carried out by Carbide's fire research men falls into three categories: (1) fire safety characteristics, (2) explosibility and stability studies and (3) special problems related to fire protection engineering.

From its first days in 1946 on through to 1955, the Fire Research Group at Carbide devoted much of its effort toward special problems related to fire protection engineering. Among these were improvement of foam techniques for fighting



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Benzene is an essential component of the polystyrene foam now being used in more and more ways as a structural insulation and in many other applications. When you need Benzene for styrene or any other chemical application, be sure to order from Enjay. In the aromatics group Enjay also markets para-XYLENE and has available ortho-XYLENE in quantities for product development and research. The complete line of petrochemicals marketed by the Enjay Company is available for industrial use.

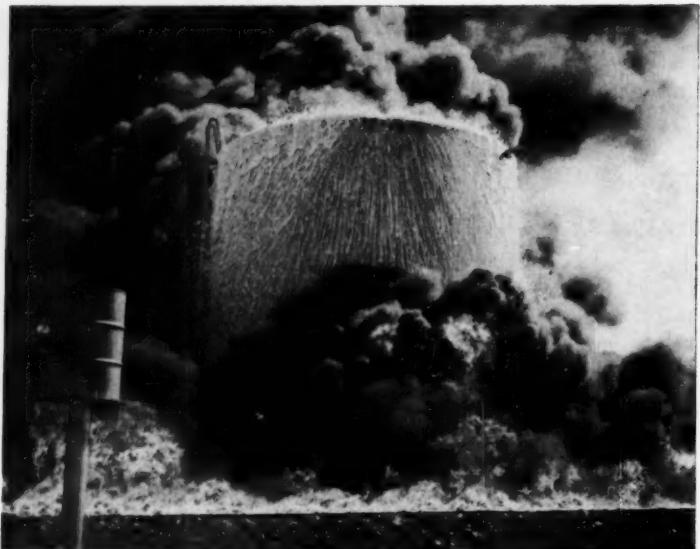
For complete information and ordering ... Write or call our nearest office. Enjay's extensive laboratories and expert staff of technicians are always ready to help with any compounding or processing problems. Shipments can be made in tank car, truck, or 55-gal. drums.

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TANK comes through fire without damage under protective mantle of foam.

fire and evaluation of heat- and fire-retardant coatings.

In the period from 1955 to the present, group effort has shifted more toward explosibility and stability studies. With this change has come a reduction in plant accidents due to explosions. And production efficiency has risen.

Continued emphasis in this direction is expected to provide data for elimination of fires and explosions. Eventually, it will reduce the need for involved fire protection systems.

► Thinking Behind Shift—What prompted Carbide to concentrate on learning more about actual mechanisms whereby danger arises is revealed by Safety Director James J. Duggan.

According to Duggan, when a research man originates a compound he cannot be expected to concern himself with hazards related to production of the material. He has made his contribution by perfecting a compound suitable for manufacture at a profit.

Next, the design engineer devises equipment and control of temperatures and pressures in order to produce material of a specified quality.

As for the production engineer who must live with the new material, he is primarily concerned with turning out the needed volume of specification product.

However, through established procedures, Carbide's process safety department spells out for the production engineer the hazards and limitations, originates preventive maintenance procedures and oversees installation of adequate fire prevention and protection measures. **► First, Prevention**—Yet, even with these precautions, there may be inherent hazard. Slightly abnormal increases in pressure or temperature may completely change characteristics of material in process so that it reacts or decomposes with explosive violence.

Need for research to control such destructive forces inherent in a chemical usually extends over and beyond the stages of development, construction and production. That's why Carbide's fire research group is assuming responsibility and seeking out the answers with its studies on explosibility and stability.

► Then, Protection—Even though Carbide's studies are

leading to more effective prevention of process hazards, work continues on protection in case of fire. According to Group Leader D. H. Way, fire is really nothing but a big problem in heat transfer. So, equipment must be protected from disastrous absorption of heat if exposed to fire.

For instance, picture on left shows a typical evaluation of a fire exposure protection system. Exposure of the 20 x 24-ft. tank to a vigorous kerosene fire lasted 45 min.

By single point application of 180 gal. of foam, tank's rate of heat absorption was reduced five or six fold. In addition to demonstrating effective protection, such a test proves out the possibility of major savings in protection costs, particularly where water supplies fall short of requirements.

Other examples of protection are use of an insulated conduit for polyethylene instrument tubing to maintain instrument control even after 4-hr. direct exposure to fire, use of paint which is sufficiently resistant to heat and fire to protect a stressed steel beam from failure during 30-min. exposure, selection of insulation which protects pipes well enough to prevent failure in a fire.

► Properties Guide Protection—Properties of a chemical such as its flash point, temperature, auto-ignition temperature, flammable limits and permissible oxygen level of environment provide keys to design of fire protection, safe handling and fire safety.

D. H. Way points out that flash point is more than a value for choosing the label color for an ICC shipping container. It is a measure of fire hazard from spilled flammable liquid, or the explosion hazard inside an enclosure.

From burning rate tests comes knowledge of how much heat a given fire will liberate and what type of exposure nearby equipment will suffer.

But with its growing knowledge of explosibility and stability of compounds, Carbide can expect to see fewer and fewer cases of such severe exposure.

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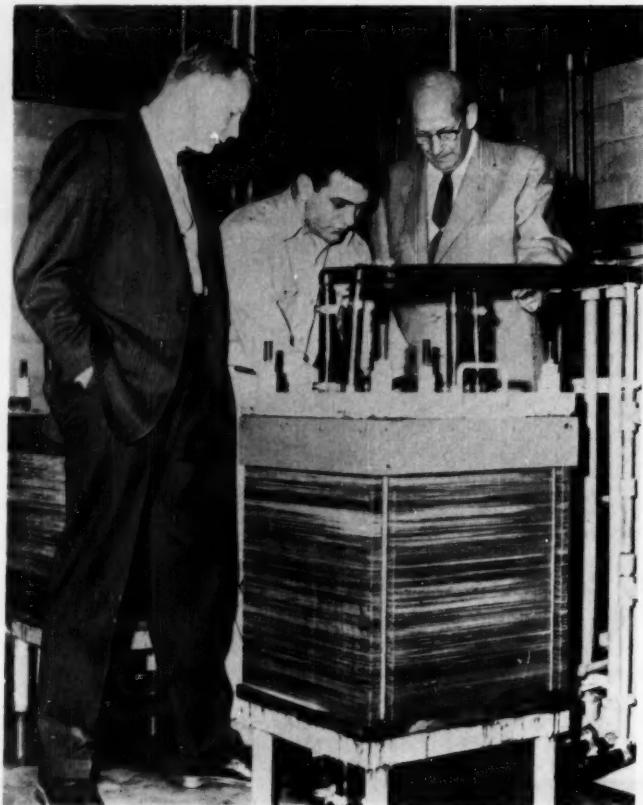
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California City First in U.S. to Desalt Water

Officials of Coalinga, Calif. examine electric membrane stack in new municipal plant that produces fresh water from brackish local well water. Delivering 28,000 gal./day into city's drinking-water distribution system, plant eliminates railroad haul-

age of fresh water in existence for 50 yr. Cost of electricity for plant, constructed by Ionics, Inc., Cambridge, Mass., runs 15¢/1,000 gal.; charges for maintenance and replacement of membrane adds another 40-80¢/1,000 gal.

More Data Revealed on New Cellulosic Fibers

Now, just a few weeks after three new cellulosic fibers were unveiled (*Chem. Eng.*, Mar. 9, 1959, pp. 69-72), maker of one of them has revealed more information on structure and properties.

Courtaulds (Alabama) Inc., in a hearing before the Federal

Trade Commission, suggested that the new cross-linked cellulosic fibers be given the generic name "lincron" to distinguish them from rayon. Courtaulds then went on to sketch physical and chemical differences between the two fibers.

Cross linking makes lincron insoluble in standard cellulose solvents and reduces cross-sec-

tional area swelling far below that of rayon. Courtaulds also noted that lincron dyes differently because of chemical differences between lincron and rayon. Lincron fabrics have improved resistance to shrinkage in laundering and can be treated with caustic soda up to higher mercerizing strengths.

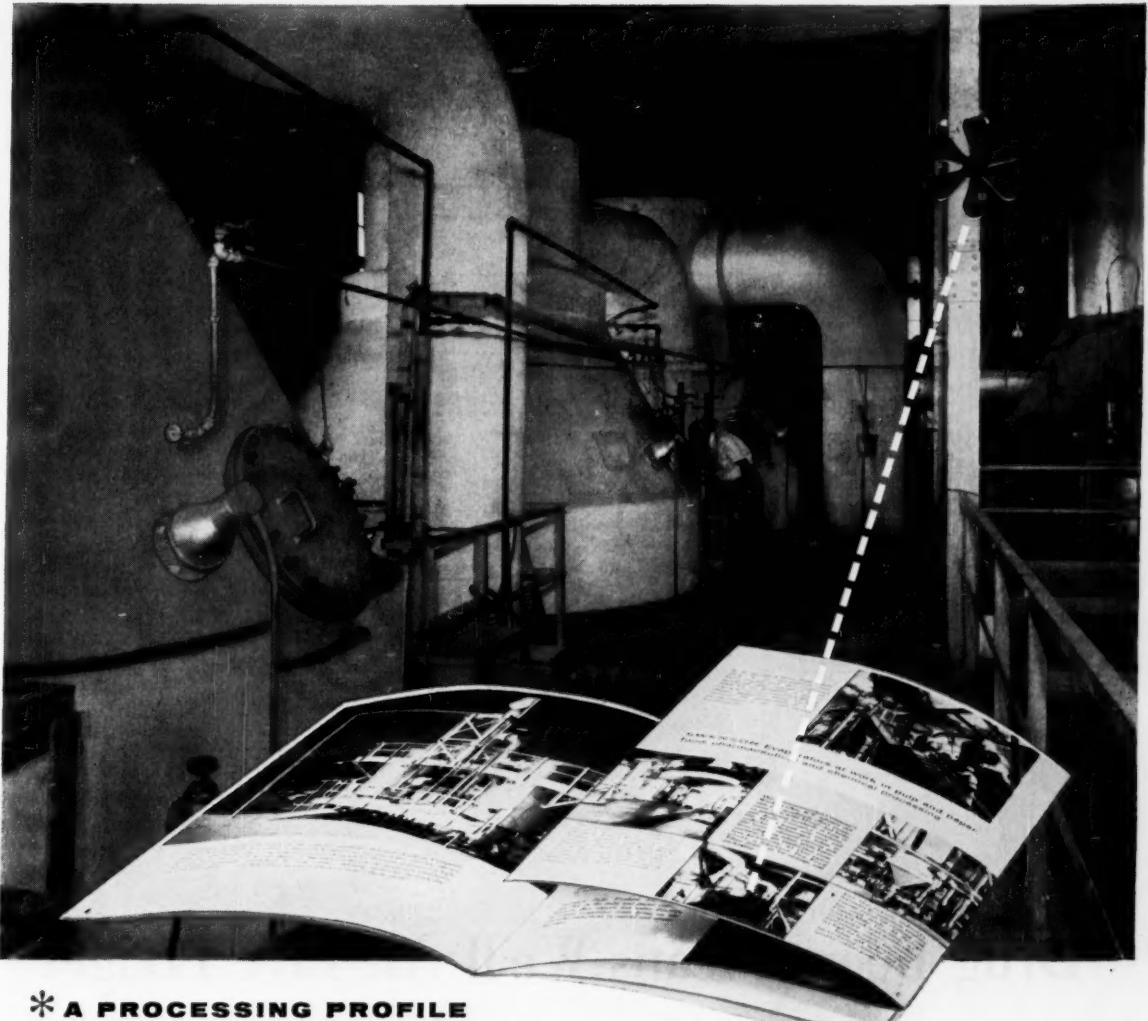
NEWS BRIEFS

Smog-fighting gasoline: Tide-water Oil Co. is marketing a premium gasoline tailor-made for the Los Angeles Basin to reduce smog. The new gasoline combats smog three ways: Vapor pressure 2½ lb. below other premiums marketed in the area will cut evaporation of raw gasoline by 50%; it's clean burning and will improve engine performance, cut down on smog-inducing emissions (1-1½% decrease in polycyclic aromatics content means less gum formers in gasoline); olefin content is reduced to level of about 15%.

No-burn paper: A Leningrad technical institute has developed a paper that resists acids, won't burn or absorb water, according to the Prague daily paper, *Prace*. Developed especially for the electronics industry, the paper is made from cotton, asbestos and glass fiber mixture.

Drilling mud for fire?: Minister of Lands and Forest has reported to the Alberta legislature of combating a forest fire from the air by spraying drilling mud. By all appearances, drilling mud proved just as effective as chemical spray, and it costs less.

Natural gas over coal: Cyanamid of Canada, Ltd., at its Niagara Falls, Ont., ammonia plant, is switching its raw material source from imported U. S. coal to natural gas purchased from Provincial Gas Co., Ltd., subsidiary of Consumer Gas Co., Ltd.



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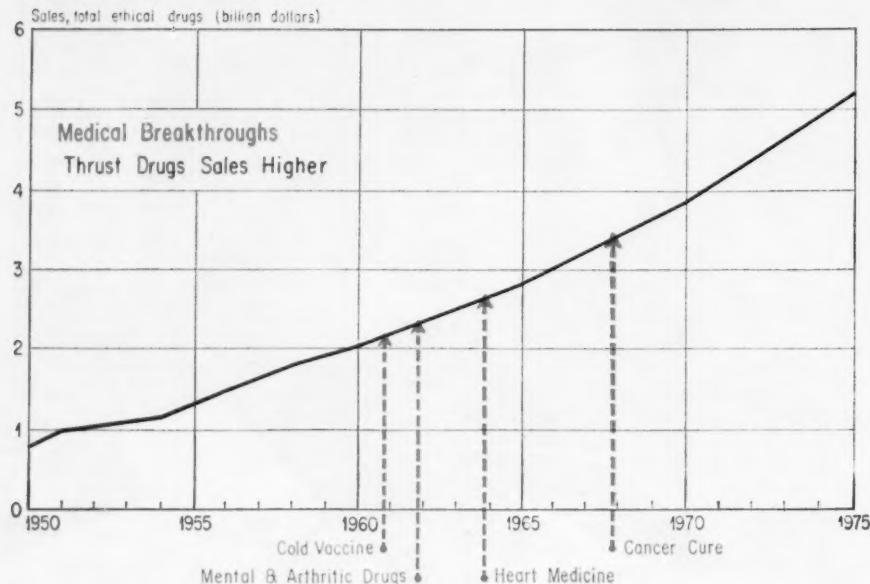


WHITING—MANUFACTURERS OF CRANES; TRAMBEAM HANDLING SYSTEMS; TRACKMOBILES; FOUNDRY AND RAILROAD EQUIPMENT

DEVELOPMENTS ...

CHEMICAL ECONOMICS

EDITED BY D. R. CANNON



Drug Boom Means We'll All Live Longer

Still-soaring pharmaceutical sales mean dividends for us all: a longer life, a life of "unprecedented health and well being."

Can ethical drug sales grow at the same high-flying pace for the next 20 years as they have in the past? Pfizer executive George Stone asks this at the outset of a recent talk, and answers it with an emphatic yes.*

Mr. Stone sees manufacturers' drug sales cresting the \$5-billion mark by 1975. Sales will reach \$2.0 billion in 1960, \$2.8 billion in 1965, \$3.8 billion in 1970, and \$5.2 billion in 1975.

Here's how Stone expects the ethical boom to continue:

- Sustained growth by such

*At the February meeting in Chicago of the American Pharmaceutical Manufacturers Assn.

robust "oldtimers" as antibiotics and vitamins—which accounted for one-third of all ethical sales in 1956—will carry the industry to 1960.

• Newer established drugs—tranquillizers, corticoid hormones and vaccines—will provide more and more steam in the early '60s (total ethical sales of \$315 million in 1956, \$430 million in 1960).

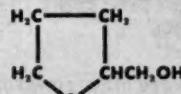
• Chemotherapeutic breakthroughs in mental disease, virus infections, arthritis and rheumatism will light another fire under ethical drug sales sometime between 1960 and

1965 (bringing new sales in these areas of \$405 million/yr. by 1965).

• Sometime in the '60s, really dramatic heart drugs will begin to appear (before 1965, perhaps), and at least one long-awaited cancer cure will be a reality. New sales in these areas alone should total about \$400 million/yr. by 1970, \$750-million by 1975.

►Big Stakes—For the drug companies and their stockholders, there will be huge rewards in dollars and cents. And huge risks, too, in the midst of a fierce, scrambling competition.

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There are other rewards, only partially measureable in terms of dollars and cents, for us all, the rewards of "a future of boundless medical advance in

an era of unprecedented health and wellbeing."

- By 1975, deaths from infectious disease will be a rarity —0.11 per 1,000 population.

- By 1975, deaths from heart disease, standing at 5.13 per 1,000 population in 1956, will have been cut to 4.40. By the year 2000, the mortality rate will have been slashed to 2.51.

- By 1975, deaths from cancer, 1.55 per 1,000 population in 1965, will be down to 0.39.

- By 1975, the common cold will be a thing of memory.

► **"Aging" Next**—And when the pharmaceutical industry finishes taking most of the sting out of these killers and chronic diseases, it can turn its all-out efforts against the most enigmatic killer of all: the deterioration of body organs and tissues we call aging.

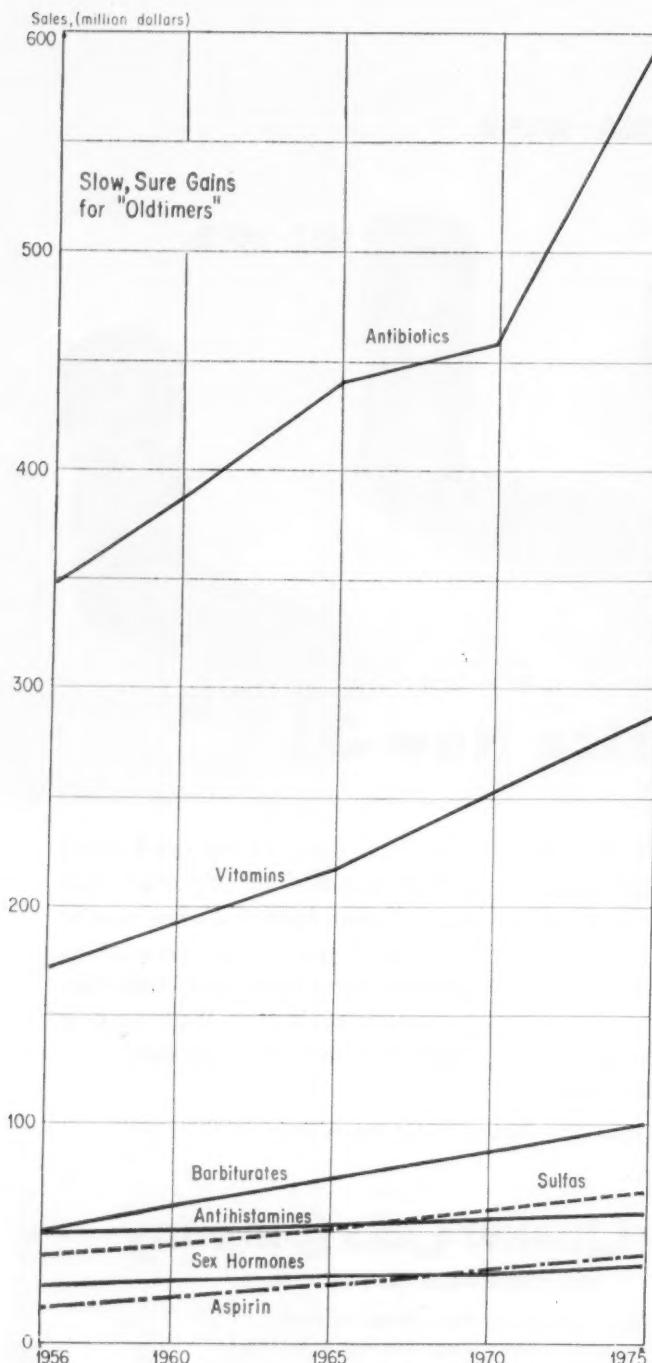
► **Drug by Drug**—As part of his study, Stone made individual forecasts for the major categories of ethical drugs existing today and destined to appear in the major medical problem areas of heart, cancer, mental disease, arthritis and virus infections. Here is how he went about it, drug category by drug category:

► **Aspirin Is Ageless Wonder**—Aspirin, and its derivatives, is by far the most important proprietary (over-the-counter) drug. However, a substantial amount is promoted and sold ethically, inasmuch as aspirin compounds are often combined with ethical drugs which require a prescription.

Look for Rx aspirin compounds to continue their smooth, strong growth, hitting sales of \$24 million in 1960, \$43 million in 1975.

► **Barbiturates Are Steady**—Virtually indispensable as sedatives and hypnotics, barbiturates represent a major category of ethical drugs. Stone figures their future rate of growth to slacken somewhat to a \$2.5-million increase per year. Two reasons for his conservatism: the number of nonbarbiturate sedatives and hypnotics entering the market in the past few years; the recent development of tranquilizing drugs which obtain some of the same results as the barbiturates.

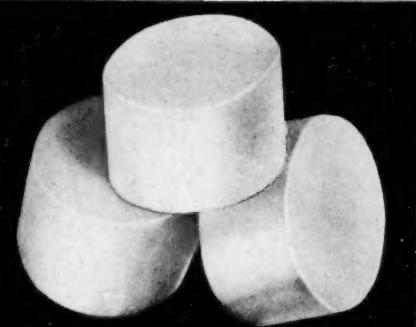
Look for barbiturates to reach sales of \$65 million in 1960, \$102 million in 1975.



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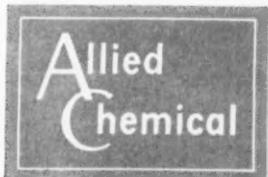
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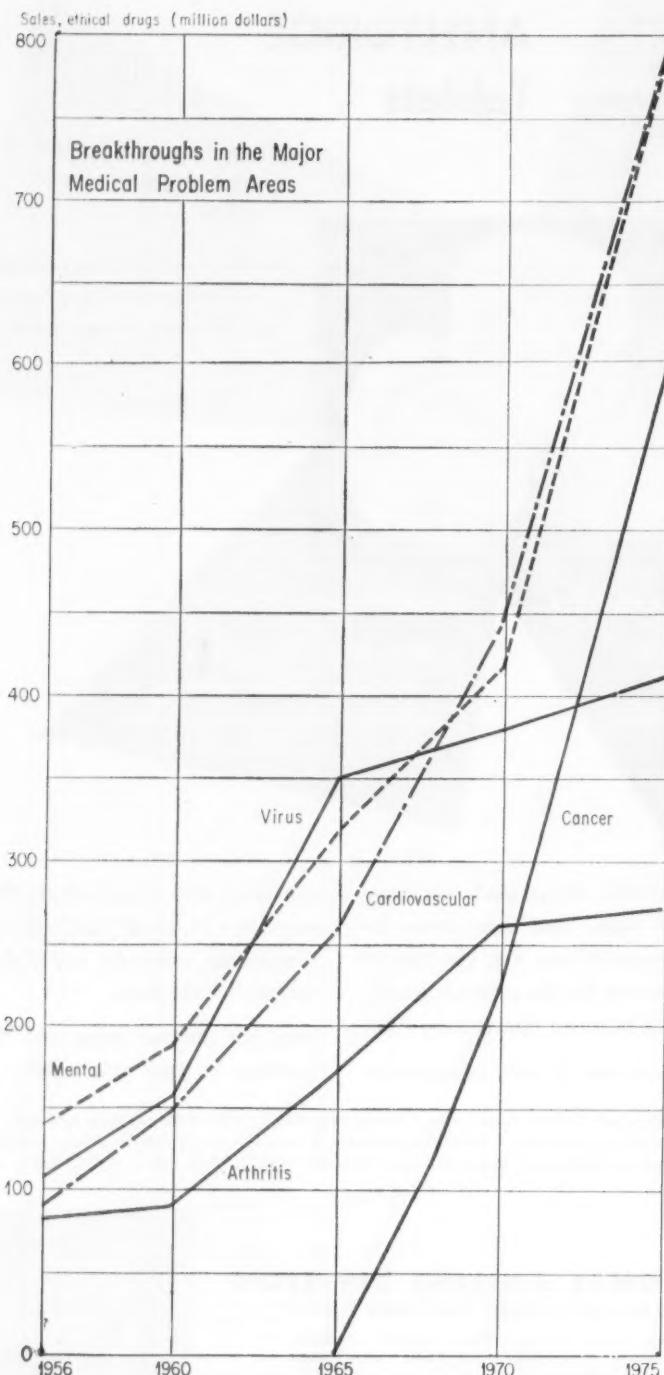
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Vitamins Are a Fixture — Since the ethical drug industry supplies a major share of the vitamin products sold through proprietary as well as ethical

channels, its stake in vitamins must include all preparations promoted to the medical profession whether sold by prescription or not.



Despite a mature growth picture, vitamin sales figure to grow faster than population in the next twenty years. Daily vitamin supplementation has become a function of standard of living and personal consumption expenditure for drugs and sundries. As the level of disposable income increases, so will, Stone predicts, the per capita daily consumption of vitamins.

He sees vitamin sales moving upward, at \$5 million/yr., to reach \$195 million in 1960, \$290 million in 1975.

Sex Hormones Slow — Originally isolated from natural sources, most male, female and progestational hormones have since the 1930s been synthesized commercially, starting with a steroid material from the Mexican yam. Their market has apparently matured; growth in the past four years has been limited. Further growth seems largely dependent on population increase since there is little opportunity for new products.

Stone puts the market for sex hormone products at \$31 million in 1960, \$38 million in 1975.

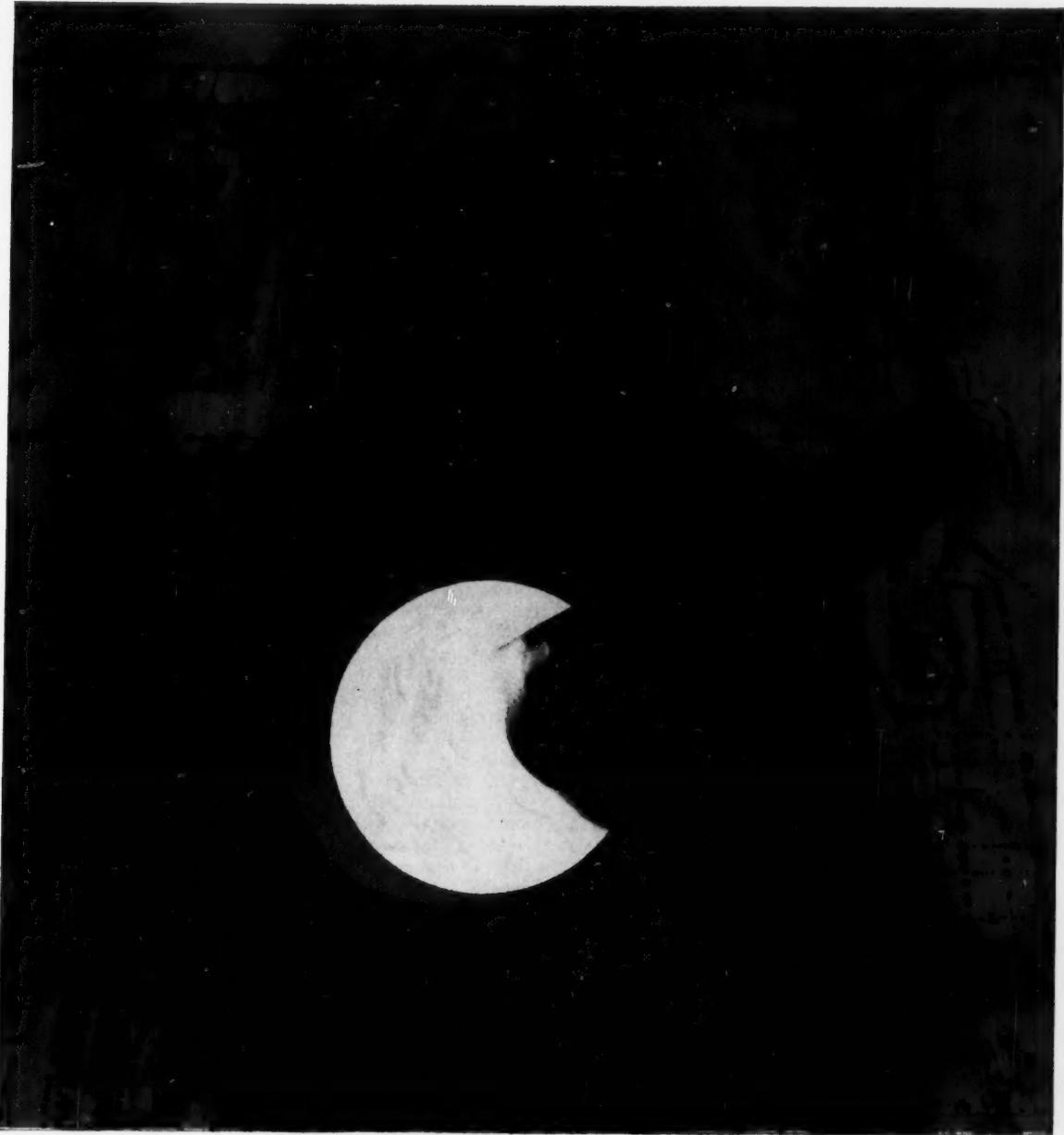
Antihistamines Lose Steam — Explosive postwar development and commercialization of antihistamines was founded on their applications in alleviation of cold and allergy symptoms. Once they finally found their proper place in the physician's bag their sales rapidly leveled off. Growth in the past few years has been steady but small. Here, too, feels Stone, growth outlook parallels population.

He expects sales of \$53 million in 1960, \$62 million in 1975.

Antibiotics Still Lead — The most important dollar category of the ethical drug industry, accounting for 23% of total sales. To predict the future of this industry bellwether, Stone draws upon his "mortality rate" technique.* This time it's the infectious-disease mortality rate, which is figured to drop from 0.34 in 1960 to 0.11 in 1975.

By attributing most of this decline to increased use of anti-

* Based on predicted over-all mortality rates and ethical drug sales required to reduce rates one unit per 1,000. Stone multiplies this mortality-sales value by expected reductions in heart, cancer and infectious mortality rates in order to forecast drug sales in those areas.



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ALCOA now offers you the lowest soda content ever available in commercial grades of hydrated alumina. Typical soda level of new Hydrated Alumina C-35 is only .040% Na₂O . . . making it ideal for use as a noncontaminating catalyst base, or as an ingredient material for fine aluminum chemicals. Here is just one more example of ALCOA's constant effort to match aluminas to product or process needs. It's another good reason why it pays to mix imagination with ALCOA® Aluminas . . . to make an old product better, or a new product possible. There is probably a type and grade of alumina precisely suited to your own needs. You can get complete information by writing ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 706-D Alcoa Building, Pittsburgh 19, Pennsylvania.

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biotics (a pretty valid assumption in this country now, what with the advances in sanitation and personal hygiene) Stone comes up with his projected sales to 1975.

From these figures it appears that antibiotics as a class are beginning to mature. Stone feels a dramatic new discovery, which would boost the leveling growth curve, is unlikely, although the ethical drug industry continues to spend heavily in the search for a new, chemically different antibiotic.

Look for antibiotic sales to top \$390 million in 1960, \$600 million in 1975.

► **Sulfa Drugs Rally**—Although small potatoes, sales-wise, compared to antibiotics, sulfa drugs have not been eclipsed. They have clung stubbornly to an important place in the treatment of infectious diseases. And, according to Stone, they figure to grow in the next twenty years just as fast as antibiotics.

Thus, sulfa drug sales should reach \$47 million in 1960, \$72 million in 1975.

► **Arthritis Cure Ahead**—Commercial development of hormones for arthritis, rheumatism and inflammatory disorders was one of the four major postwar medical breakthroughs.

Future growth is difficult to predict. Although arthritis and rheumatism is one of the five major medical problem areas now under study, the corticoid hormones while important, even life-saving, are, Stone cautions, only a palliative, not a cure or preventive.

The heavy research spending in this area makes likely the emergence of some form of chemotherapy, not palliative treatment, in the near future, probably by 1962. Such a discovery, predicts Stone, will mushroom the arthritis and rheumatism market just as the corticoid hormones did between 1950-56.

The 1962 breakthrough could lead in the next ten years to a market of \$160 million—twice as great as the present corticoid market—without affecting the existing market.

Thus, while sales in the rheumatic-arthritis disease area will total only \$88 million in 1960,

they will soar to \$270 million by 1975.

► **Cold Vaccine Coming**—Immunological agents, better known as biologicals and vaccines, "are a class of drugs in renaissance." Shoved aside by the onrushing antibiotics from 1945-50, they had to wait until it was clear that antibiotics don't perform miracles against virus diseases—polio, common cold, measles, flu.

Then in 1955 they surged upwards again, adding sales of \$46 million, due to the Salk polio vaccine discovery. In 1957 the Asian flu vaccine was another strong sales boost. And there are two other areas—a vaccine for the common cold and a vaccine for measles—which promise new sales in the foreseeable future.

An effective common-cold vaccine is just around the corner—1962 at the latest. Eighty percent of the population will wish to be immunized.

In terms of dollars and cents, the initial immunization will call for \$230 million worth of vaccine, with \$80 million/yr. thereafter for booster shots. (In his chart, Stone spreads the initial sales over three years.)

A measles vaccine, expected by 1968, represents a smaller sales potential because it will probably be restricted to children under 12 and women of child-bearing age. Initial sales will be comparable to those for polio vaccine—about \$50 million the first year, much less in succeeding years.

Initial measles-vaccine sales, however, will not jump over-all biological sales in 1968. They will merely compensate for the falling off of cold-vaccine sales following complete initial immunization about 1966-67.

Thus, biologicals and vaccine sales, at \$155 million in 1960, will rise to \$350 million in 1965, \$410 million by 1975.

► **Heart Drugs Aim for Sky**—Heart disease—the number one killer today, accounting for more than half the mortality rate—will soon be the ethical drug industry's number one target, and biggest sales-potential bonanza. Nearly 14 million people suffer from minor and major cardiac disorders.

Mortality rate for heart disease is still climbing but will peak, Stone says, at 5.31 deaths per 1,000 population in 1962. For it is then, Stone believes, that medical discoveries will begin to cut the rate so that by 1975 it will be 4.0, and in 2000 only 2.51. With these mortality rate assumptions as a basis, he projects heart drug sales required to bring about reductions in those rates.

Cardiovascular sales are pegged at \$147 million in 1960, \$259 million in 1965, and a whopping \$800 million by 1975.

► **Cancer Payoff by '65**—Mortality rate of cancer, the number two killer disease in the country today, is still rising, too. But a major chemotherapeutic discovery is expected by 1965. This will stem the mortality tide at 1.55 deaths per 1,000 population, and, together with further achievements, hammer it back down to 0.39 in much the same fashion as streptomycin and, later, isoniazid slashed tuberculosis's mortality rate from 1.31 to 0.09 in ten years.

Assuming this, then, Stone sees cancer-drug sales exploding to \$116 million in 1968, \$216 million in 1970, \$600 million in 1975.

► **Mental Drugs in Infancy**—Even assuming important chemotherapeutic drugs for mental disease by 1962, the future sales of this segment of the industry are difficult to predict. Stone turns to statistics for cancer, which, except for mortality, resemble those for mental diseases.

The number of hospitalized mental patients about equals cancer patients under treatment. New mental patients hospitalized each year are about the same in number to the newly-diagnosed cases of cancer each year. Cost of medical care for a mental patient in hospital parallels that of a cancer patient — \$1,075 for cancer, \$1,112 for the mental patient per year. So, concludes Stone, the cost of drugs for long-term treatment might be the same.

Mental drug sales should reach \$185 million by 1960, \$316 million by 1965, and \$800 million in 1975.

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Below are photographs of two of the many tests that have been made of Midwest Welding Fittings. The results are always the same . . . the seamless pipe to which the fittings are welded invariably bursts. There is never any sign of fitting failure or weakness.

There's good reason for this. We make elbows and tees of inherently stronger metal . . . the Midwest exclusive method of manufacture enables us to maintain greater minimum wall thickness, and to reinforce the fittings at points of greatest stress. For the many other advantages of Midwest Fittings, ask your Midwest distributor or write us for Catalog 54.

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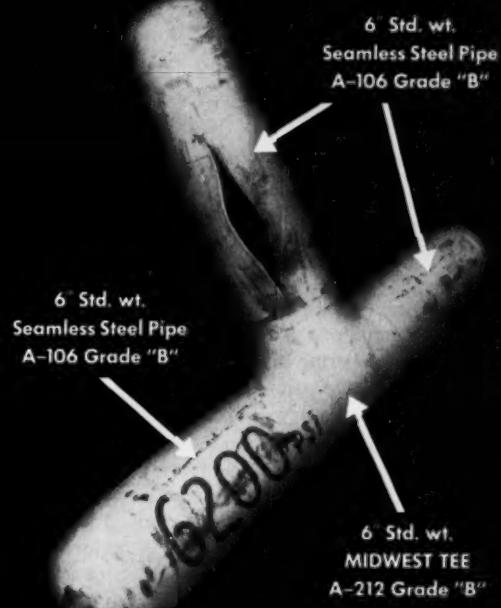
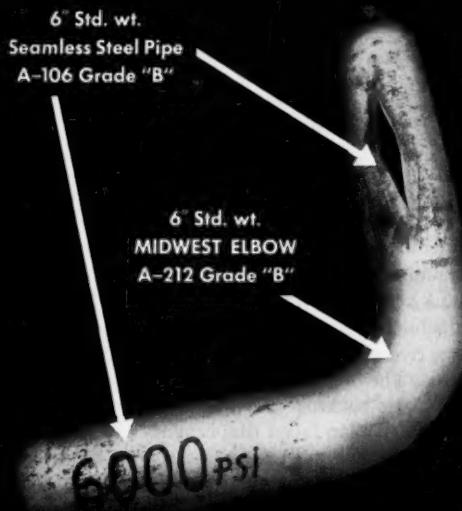
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Typical bursting test of stock Midwest Welding Elbow. As is always the case, failure occurred in the seamless pipe while the elbow was undamaged. Bursting pressure was 6000 psi . . . considerably above the required code minimum for seamless pipe. (Minimum allowable bursting pressure for 6" standard weight A-106 Grade B seamless steel pipe is 4438 psi.)

Bursting test of Midwest Welding Tee taken at random from stock. As always, the failure occurred in the seamless pipe and not in the fitting. The non-shock internal bursting pressure of 6200 psi is well above the code minimum for seamless pipe. (Minimum allowable bursting pressure for 6" standard weight A-106 Grade B seamless steel pipe is 4438 psi.)

7761

MIDWEST

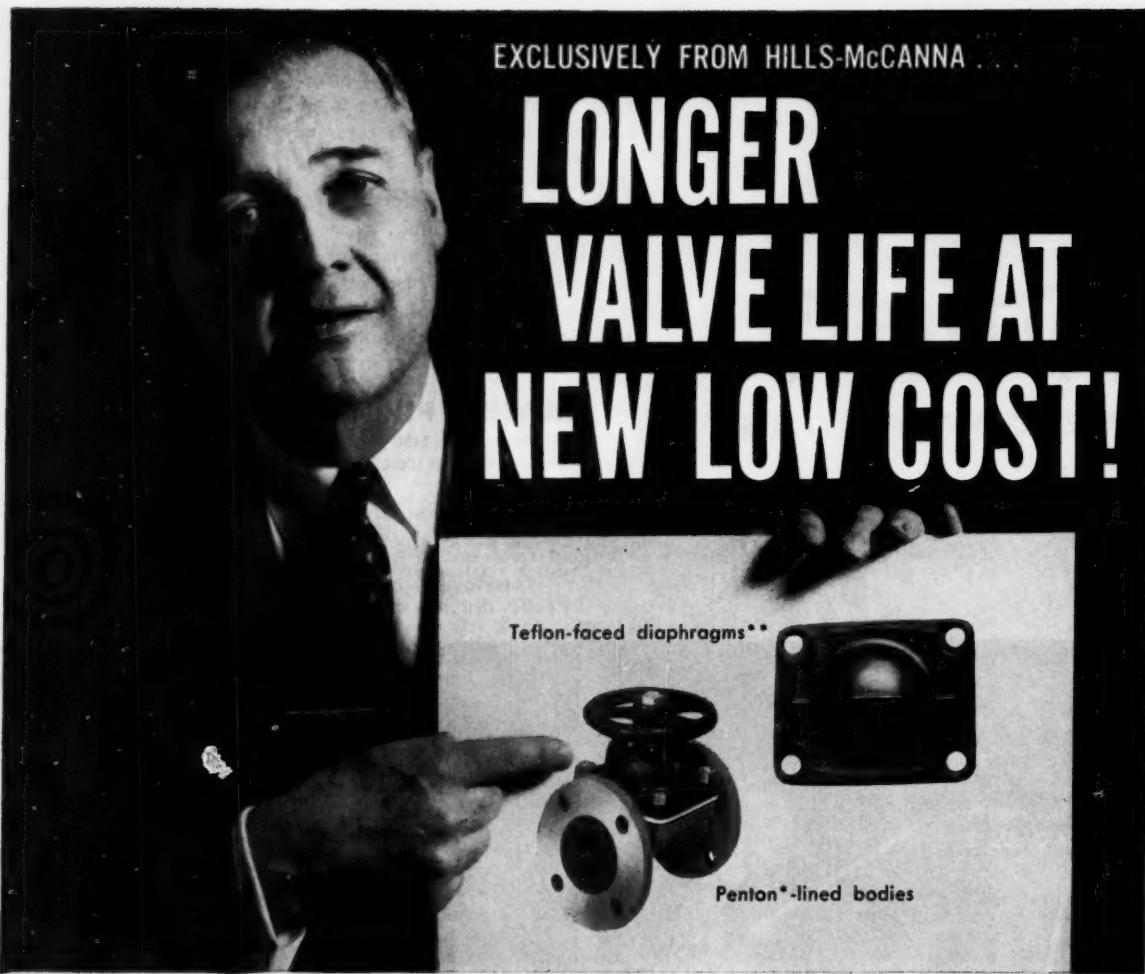
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Teflon-faced diaphragms**

Penton*-lined bodies



Hills-McCanna Diaphragm Valves—lined with Penton plastic and equipped with one-piece Teflon-faced diaphragms—are ushering in a whole new era of extra valve life and lower valve costs.

PENTON-LINED VALVES are suitable for operating temperatures up to 300°F. Penton-lined valves will save you money because they meet many service requirements that formerly called for costly stainless steel or glass-lined bodies—yet are competitively priced with rubber-lined valves. In addition to having superior corrosion resistance, they are non-contaminating—cannot affect

a product's taste, aroma, or color—work equally well with metallic, plastic, glass or lined piping.

TEFLON-FACED DIAPHRAGMS are suitable for temperatures up to 240°F. They can handle concentrated sulfuric or hydrochloric acids, chlorinated hydro-carbons, and esters. The Teflon facing is permanently bonded to an elastomeric backing—provides long life, assures positive closure. Teflon-faced diaphragms save you money because they often meet the same service requirements as solid Teflon diaphragms at much lower cost.

*Penton is a registered trademark of Hercules Powder Company.

**Patent applied for. †Teflon is a registered trademark of E. I. DuPont.



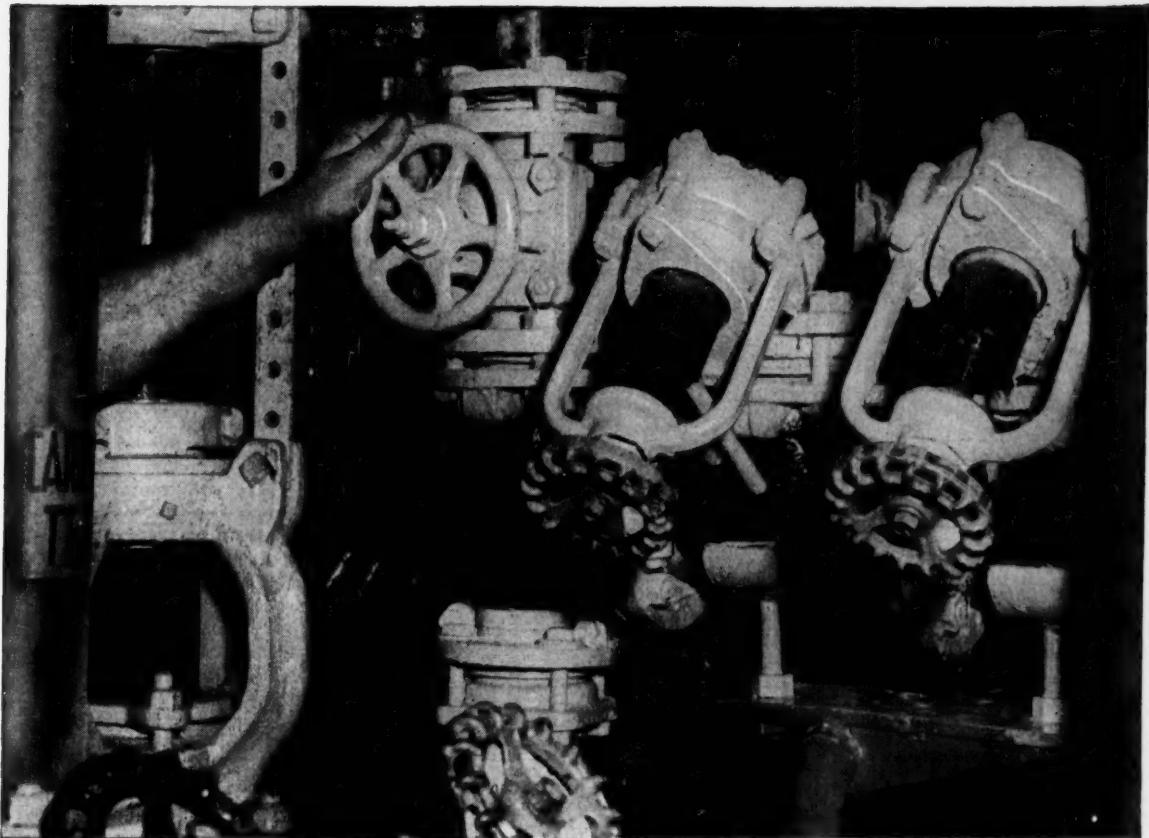
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THE PEOPLE WHO KNOW AND CONTROL FLOW



THE INSIDE STORY OF 40 MONTHS RESISTANCE TO CORROSION ACIDS

Here's still another "proved-in-action" case history of Penton*—the new thermoplastic polymer with exceptional resistance to corrosion at elevated temperatures.

THE CHALLENGE: The highly corrosive chemical processing installation pictured above. In the heart of this complex of valves and piping made of Haveg, glassed steel, porcelain and Pyrex, is this Hills-McCanna diaphragm valve with a cast iron body *lined with Penton*. Mounted above a glassed steel vessel used for hydrocarbon chlorination, it is continuously exposed to carbon tetrachloride, hydrochloric acid, and wet chlorine at tempera-

tures up to 85°C.

THE RESULT: Right at home with these expensive corrosion resistant materials, this low-cost Penton valve first placed in service September 29, 1955, has operated *without a single failure for over forty months*.

Now you can get valves, pipe and fittings, pumps and meters, flame-sprayed or whirl-sintered parts protected by Penton. Whether you make or use processing equipment, we'll be glad to send you "The ABC's of Penton for Corrosion Resistance", and the technical brochure on Penton's properties and uses. Just write:

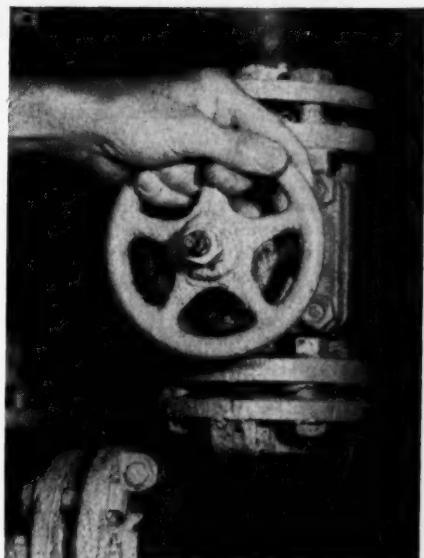
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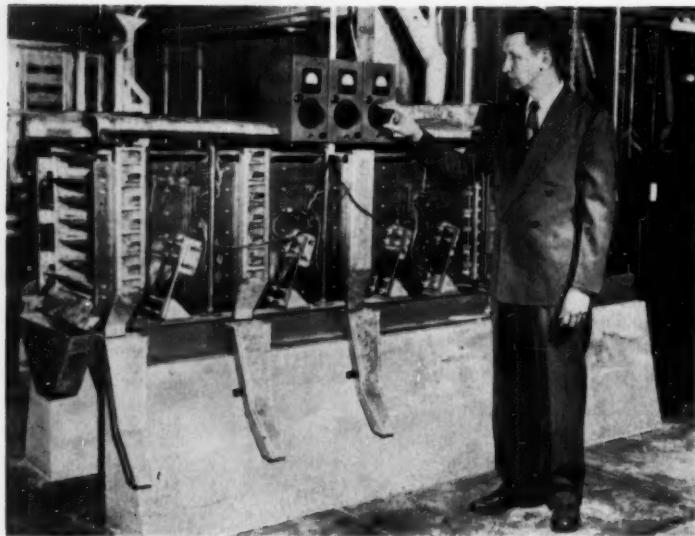
900 Market Street, Wilmington 99, Delaware



This Hills-McCanna diaphragm valve in service without failure since 1955 has a cast iron body and a Penton lining. Hills-McCanna also makes Penton-lined valves with aluminum bodies, and the same type valve with a solid Penton body.

DEVELOPMENTS . . .

PROCESS EQUIPMENT EDITED BY C. C. VAN SOYE



New Electrostatic Separator Hunts for Jobs

Want to separate salt from pepper, zircon from sand? Versatile E-Machines may solve your problem.

Shown above is one commercial-scale model of the E-Machine, General Mills' recently developed electrostatic separator. GM says that E-Machines will not only step up the degree of precision possible for electrostatic separation, but will also make it possible to easily segregate mixtures heretofore considered very difficult to separate.

E-Machines differ from other separators in a number of principles. For example, they use prolonged rather than brief exposure of particles to charging. And operation places emphasis on induced rather than frictional charges. According to GM, the equipment can separate mixtures of granular solids on the basis of particle density, size, shape or electrical charging rate.

In operation, a high-tension metal plate applies an electric field to particles vibrating along

a metal deck below. Voltage is adjusted until induced charges on the particles are sufficient to preferentially lift some of the particles through holes in the upper plate. Collars around the holes prevent lifted particles from falling back down to the vibrating deck.

Commercial-size machines have up to seven decks, each 2 to 3 ft. wide and up to 6 ft. long. The unit shown above has a feed capacity of about 50 lb./min. Use of the E-Machine is limited to materials of granular nature that can be handled by vibratory feeding.

Suggested applications range from segregation of mixed grass seed to separation of rare minerals from beach sand. GM is now inviting prospective users to submit problems for analysis.—**General Mills, Inc., Minneapolis, Minn.**

100A

Speed Control

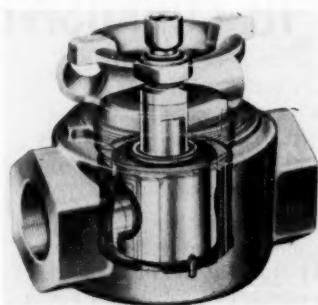
Protects driven equipment against high-speed starts.

A new electric control system provides remote dial control for the manufacturer's U. S. Vari-drive variable-speed motors. This control may be located any distance from the motor; it enables presetting of drive speed before starting.

Control components consist of: An operator's station with graduated control dial and start, stop and emergency-stop pushbuttons; a control unit; and the electric actuator motor and shifting mechanism. Speed change over the full range takes about 10 sec.

Under normal stop conditions, the control automatically returns the drive to low speed. This protects driven equipment from high-speed starts.—**U.S. Electrical Motors, Inc., Los Angeles, Calif.**

100B



Plug Valve

Never needs adjustment and cannot stick.

Unlike most high-pressure plug valves, the new Series D plug valve is not tapered. Instead, it has a straight cylindrical seat with segmented design. According to the manufacturer, the valve is stronger and 40% lighter than conventional tapered plug valves, and needs approximately 50% less turning force. Series D units



"TALK IS ALL ABOUT THE FIFTEEN MILLION FEET OF UNIONWELD STAINLESS PIPE AND TUBE NOW USED IN PROCESS PLANTS."

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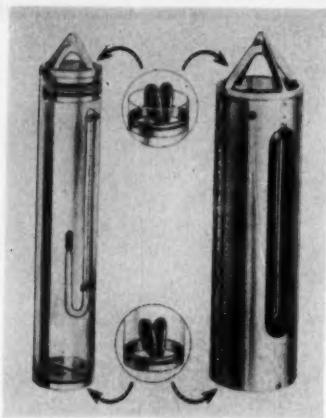
STAINLESS PIPE AND TUBE

are applicable in lubricated or nonlubricated service.

Seating surface of the plug fits into a set of four metal segments serving as replaceable seats in the valve body. Seats are locked together and float slightly in their synthetic elastomer backing. Under pressure, the seal segments rest metal-to-metal against the body.

Designed for 15,000 psi., the new valves come in 1- and 2-in. sizes.—**Hamer Valves, Inc., Long Beach, Calif.** 100C

fer of the sample from bob to sample bottles. Furnished in 1/5-, 1-, 1 1/4- and 2-qt. sizes.—**The Johnston & Jennings Co., Cleveland, Ohio.** 102A



Sampling Bob

Takes accurate samples from any tank level.

A new sampling bob takes more accurate and more undisturbed samples of liquids held in bulk storage, barge or marine tanks—from any level—than previously possible, according to the manufacturer. Two models are offered: One has a clear plastic cylinder for sampling light products with low viscosity; the other has a brass cylinder for sampling heavier products with high viscosity or with temperatures up to 200 F.

Sensitive butterfly valves in both ends of the bob open wide as the bob passes down through the product. When the downward movement of the bob ceases, both valves close automatically, thus trapping an accurate, undisturbed sample of the material from that level in the tank.

A specially designed funnel stops evaporation during trans-



Chain System

Offers greater heat transfer area per unit length.

Introduction of a new economical chain system for reduced operating and maintenance costs in wet-process cement kilns, lime sludge kilns and wash mills has been announced by Allis-Chalmers. Known as Spira-Loop, the chain system offers more heat transfer surface—shorter lengths are needed to effectively dissipate heat. Loop design eliminates concentration of wear. And, inside diameter is always greater than twice the cross-sectional area; hence, no kinking.

Spira-Loop systems are available in low-carbon, alloy or stainless steels, or in any other material that can be cold formed. Separate lengths are available for convenient replacements.—**Allis-Chalmers Mfg. Co., Milwaukee, Wis.** 102B



Liquid Feeders

For extremely low flows of clear liquids.

Known as the Micro-H, a new liquid chemical feeder accurately meters, regulates and feeds continuously at extremely low flow rates—from 0.1 to 4.0 gal./day—into a liquid stream. For proper operation, the liquid chemical must be free of suspended solids, and should possess sufficient transparency to permit viewing of the feeder's scale.

Another new feeder, the Super-H, feeds liquids at flow rates from 1 to 500 gal./day.

Micro-H (shown above) utilizes a porous stone and a built-in ejector to feed the chemicals; Super-H utilizes a variable-area metering tube.—**Fischer & Porter Co., Hatboro, Pa.** 102C

Drum Pump

Delivers controlled volume of stored liquids.

New Enpo controlled-volume drum pumps will deliver 10 to 12 gph. against a 30-ft. head, pumping directly from storage to process equipment. The pump is specifically designed for operations in which a liquid must be pumped into a mixing vat in exact proportion.

Enpo pumps are manufactured for 15-, 30- and 55-gal. drums. All sizes utilize carbon steel for noncorrosive liquids and stainless steel for corrosive liquids.—**Piqua Machine & Mfg. Co., Piqua, Ohio.** 102D

For More Information . . .

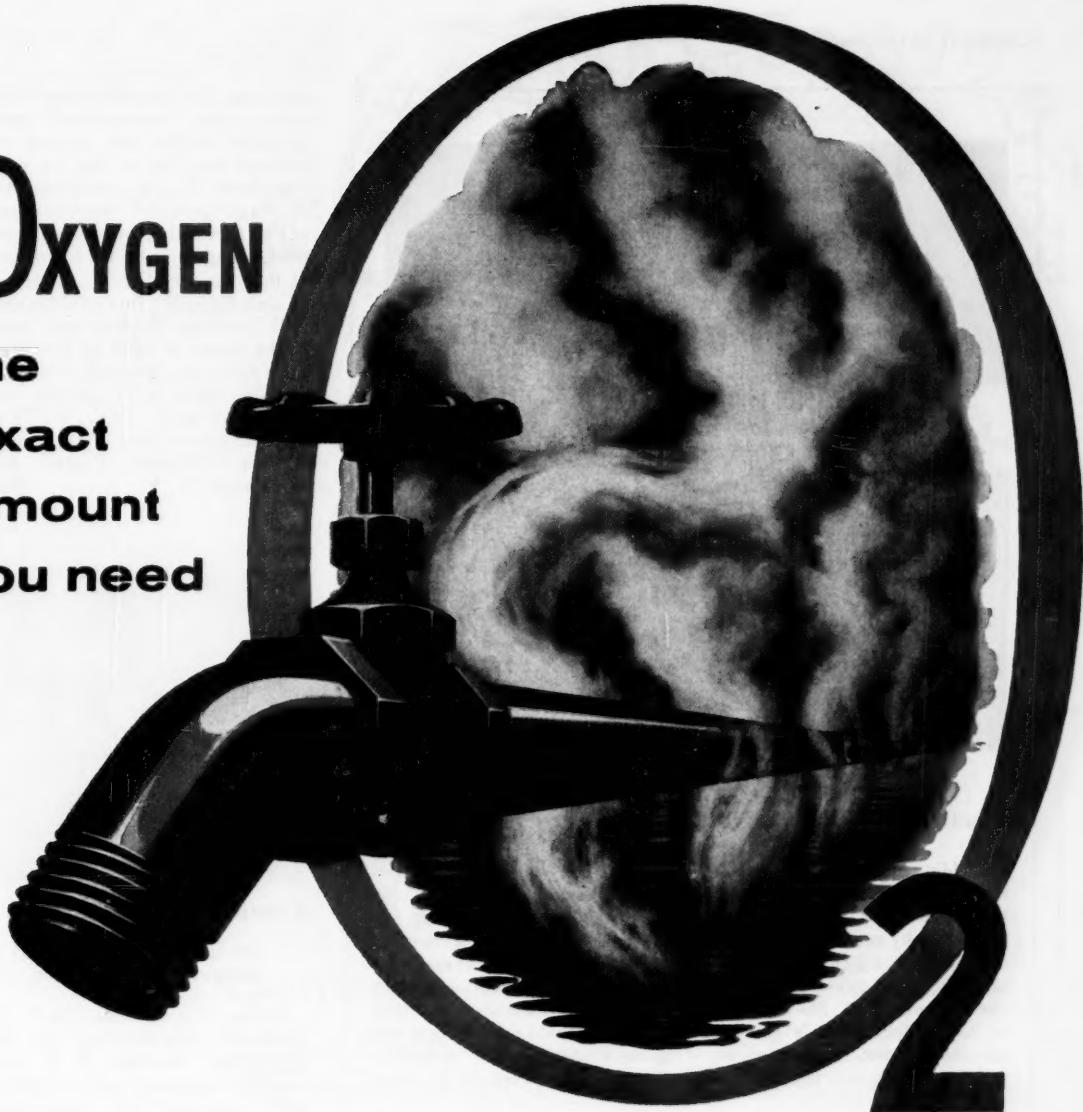
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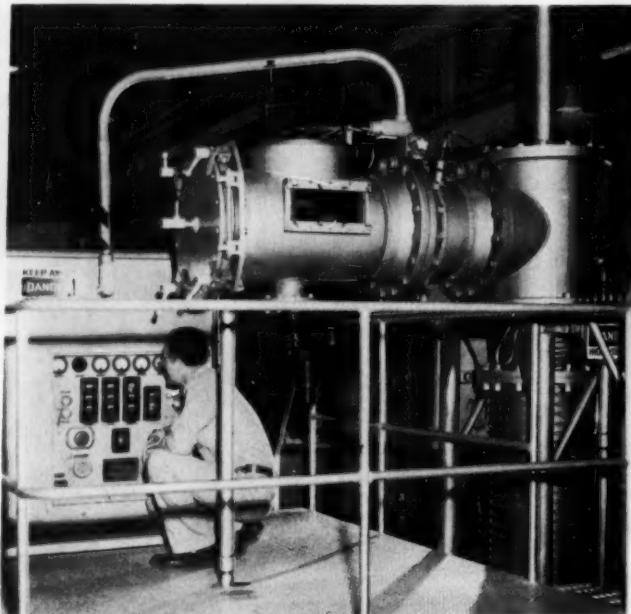
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Electrons Bombard Exotic Metals Into Submission

Welding of exotic metals—beryllium, molybdenum, tantalum, zirconium, hafnium—is a task that, by conventional methods, is very difficult. However, electron beam welders can do the job quite well. Shown above is Air Reduction Co.'s recently unveiled welder. Built as a custom item for specific applica-

tions, it can produce an electron beam as small as $\frac{1}{8}$ in. dia. for close weld control. Welding operations take place in a chamber under very high vacuum—atmospheric contamination is eliminated. Air Reduction says that resultant welds are stronger and more ductile. — Air Reduction Co., Inc., New York, N. Y. 104A

Water Heaters

Standardized line comes in many sizes.

A new, pre-engineered, fully standardized line of water heaters features extra-large steam entrance area that prevents tube damage by impingement, thus prolonging tube life. Standard construction consists of steel shells, cast iron bonnets, and seamless, copper alloy U-tubes.

Designated Type U-100, the units come in 128 sizes with two- and four-pass arrange-

ments, nominal tube lengths up to 10 ft. and shell diameters through 20 in. Tube bundles are removable. — American-Standard, Industrial Div., Detroit, Mich. 104B

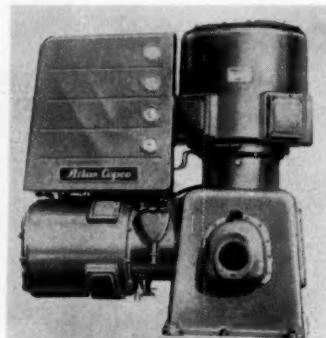
Electron Accelerator

Cuts sterilization costs per pound of product.

Dynamitron, a new low-cost, high-voltage electron accelerator, is now being marketed for high-production sterilizing op-

erations. The manufacturer estimates that "on-the-line" sterilization costs per pound of product can be as low as one-twentieth that of methods employing "job-lot" sterilization.

For sterilizing purposes, beam penetrating power is estimated at 0.33 cm./mev. for a material of unit density; this penetration will increase to 0.81 cm./mev. if the beam is split to irradiate both sides of a product. The unit will be made available in two sizes—1.5 mev. with 15 kw. of beam current, and 3 mev. with 30 kw.—Wilmot Castle Co., Rochester, N. Y. 104C



Compressor

Designed for permanent or temporary installation.

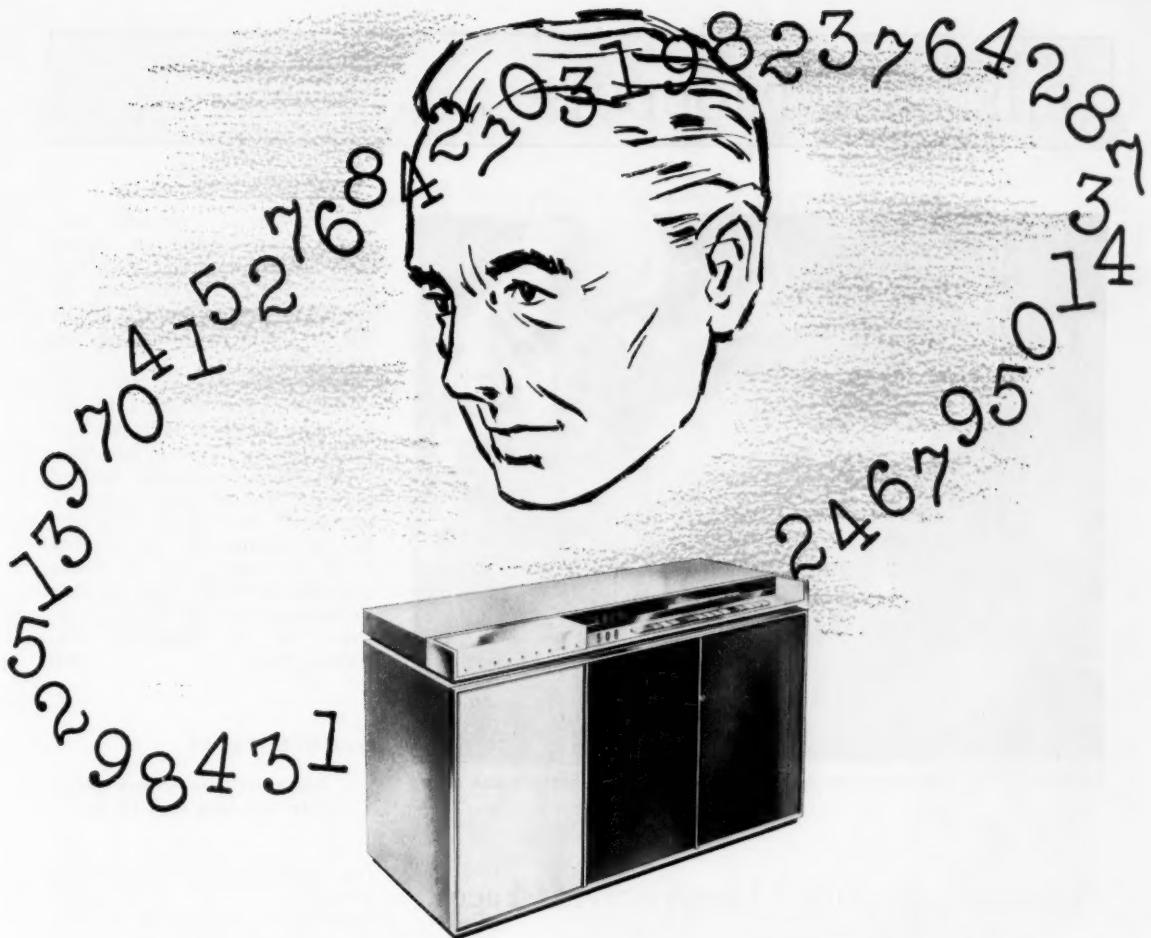
Atlas Copco has just announced introduction to the American market of a compactly designed and economically operated air compressor that delivers 1,075 cfm. at 100 psi. Company spokesmen say that the new ER-6, which weighs 6,600 lb., may be installed either as a stationary unit or mounted on a skid-frame as a semiportable machine.

ER-6 needs only about half to two-thirds the floor space required by other machines delivering comparable amounts of free air. Full-load power consumption ranges from 10 to 15% less than machines with similar output. The compres-

EQUIPMENT NEWS

Continues on . . .

Page 218



GPE Controls LIBRATROL®-500

...anyone with a head for figures can
program this digital computer for on-line application!

Any accountant or engineer — anyone who can work out a sequential problem on an ordinary desk calculator — can program the GPE Controls Libratrol-500. It is by far the easiest digital computer to program and operate.

For example, command and address data are a part of every word. This arrangement insures accurate programming without a great deal of specialized knowledge and training. An engineer can

learn to program a simple problem in two hours.

Libratrol-500 was designed for industrial automatic control—designed for simple yet comprehensive operation. Your GPE Controls man can give you all the facts.

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See the Libratrol-500 IN ACTION at the 5th World Petroleum Congress Exposition, Booth 376, New York, June 1-5

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CHEMICAL ENGINEERING—April 20, 1959

DEVELOPMENTS ...

CHEMICAL PRODUCTS

EDITED BY FRANCES ARNE



STEEL COILS and sheets are now coated in vinyl with texture and color.

Permanent Coating Changes Steel's Face

Directly-bonded liquid vinyl can now transform the serviceable face of steel to one with color, warmth and texture in desired variety.

U.S. Steel has just started commercial marketing of vinyl-coated steel which it describes as having the toughness and structural durability of steel plus the appearance and feel of linen, leather or any texture wanted. The products can be produced in any specific color.

Products made of vinyl-steel are fabricated without damage to the coating on existing customer equipment in essentially the same manner as cold rolled sheet. U.S. Steel officials point out that it retains complete bond and surface texture even after drawing or forming.

Sheets are available in 18 through 28 gages and in widths from 24 to 52 in. Lengths can run 30 to 144 in. The vinyl-steel also is available in coils.

Company claims the coatings last indefinitely. Coils of cold rolled or galvanized sheets feed into a cleaning unit. A light phosphatizing treatment etches the surface slightly and leaves a fine chemical deposit. Sheet is roller coated with a thin thermoplastic adhesive film. Another roller coater applies a corrosion protective primer to the reverse side of the sheet if desired by the customer. Adhesive and reverse surface protection are cured simultaneously in an oven. The liquid vinyl coat comes from a reverse roller coater and is heat cured on the steel. Coating thickness ranges from 0.008 to 0.020 in., again depending on customer's desire. While hot, the steel passes through embossing rolls to give texture to the vinyl.—U.S. Steel Corp., Pittsburgh.

A new metal coating system for bonding vinyl plastic to steel, announced by B. F. Good-

rich Industrial Products, features a new adhesive. Sheet steel bonded to vinyl with the new A-978-B cement can be stretched 35% without weakening the bond or damaging the vinyl coating.

According to Goodrich, no other vinyl-to-metal adhesive has passed torture tests devised to evaluate the new material. These tests—including boiling in water for 30 min., exposure to 200 F. for seven days and humid storage at 160 F. for 1,000 hr.—are said to prove that the A-978-B bond remains as strong after stretching as before.—B. F. Goodrich Co., Akron, Ohio.

106B

Gelling Agent

Instantly transforms water-thin solution to stiff gel.

Known as Cyanogum 41 gelling agent, a new product is expected to have broad industrial application because of its ability to gel solutions containing a wide variety of materials such as clay, charcoal, sawdust and cement-sand mixtures.

Available as a dry white powder, Cyanogum 41 dissolves in water to form a nonviscous solution that will gel in a controllable length of time after the addition of a catalyst.

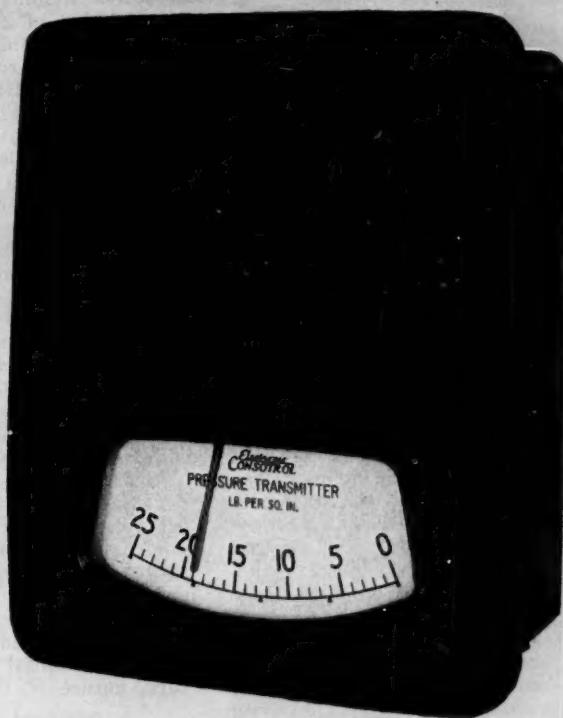
The catalyst may be added immediately after the Cyanogum 41 solution has been prepared, or as much as 24 hr. later. By using one catalyst system, a gel will form by simply raising the temperature of the solution to 190 to 200 F.

There are other catalyst systems for producing gels in a predictable length of time over the temperature range of 26 to 185 F. With these catalysts the gel times can be controlled within 10% over a period ranging from seconds to hours by varying the amount and type of catalyst and temperature.—American Cyanamid Co., New York, N. Y.

106C

versatile unit in Foxboro's exclusive 100% solid-state electronic system

Indicating
Consotrol*
Transmitter
Type 630



- local indication — independent of power supply
- magnetic amplification for greatest reliability

An electronic transmitter, with local indication, for long-distance transmission of a wide variety of process measurements — that's the Foxboro Type 630 Consotrol Transmitter.

The Type 630 operates with standard Foxboro measuring elements. Its magnetic amplifier delivers a high level (10-50 ma) d-c signal — unaffected by a-c pick-up and ambient temperature variations. Indicator, and optional local alarms, work

directly from mechanical primary element. Standard instrument is weatherproof — optionally available for use in hazardous area.

Write Foxboro today for Bulletin 21-10. It describes the Type 630 Indicating Transmitter in detail, as well as the many other instruments in the 100% solid-state Foxboro Electronic Consotrol System.

The Foxboro Company, 364 Neponset Ave., Foxboro, Massachusetts.

*Reg. U. S. Pat. Off.

Motion-Type Electronic Consotrol Transmitters:

FLOW AND LIQUID LEVEL
differential pressure diaphragm-bellows elements . . . ranges between 20 and 200 inches of water

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diaphragm, bellows, and bourdon-type elements . . . ranges between 10 inches of water and 80,000 psi

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ELECTRONIC CONSOTROL INSTRUMENTATION / for every function
in the control loop



Polypropylene Rope

For boat hawser, can be handled by one man instead of three for manila rope.

A polypropylene hawser that is 7 in. in circumference weighs approximately 1 lb./ft. Manila rope of equivalent strength measures 9 in. and weighs nearly 2.5 lb./ft., picks up additional weight when wet.

Polypropylene rope is light enough to float, does not pick up any water or freeze like conventional ropes. It is said to have superior gripping power because surface isn't slippery, it resists kinking, resists rotting from solvents, greases, oils and water.—American Mfg. Co., Brooklyn, N. Y. 108A

Active Alumina

Priced between gel and granular, it's said to equal gel performance.

High absorptive capacity, physical strength and surface area, low pressure drop and good thermal stability are claimed for a new type of alumina in the form of spheres. Its price is somewhat higher than granular material's, considerably below alumina gel's.

Company claims product has 25-33% more water absorption than that of granular material, about the same capacity as that

of gel. This means longer drying cycle with fewer reactivations. Also, smaller equipment is required for a given drying load. Capacity can be increased by increasing the gas flow through existing absorbers.

Crushing strength is 25 to 33% higher than that of granular active aluminas, about the same as that of gels. Particle breakdown is said to be at a minimum due to rugged nature of the spheres. High crushing strength and abrasion resistance minimize dust formation.

Closely controlled sphericity of product results in minimum pressure drop with a resultant savings in power costs. Packing and channelling are reduced. The spherical form is offered in size range from $\frac{1}{2}$ - $\frac{1}{4}$ in.

Typical surface area of the new product is 300 sq. m./gm. Granular material: 210 sq. m./gm. Gel: 350 sq. m./gm. The high surface area and good thermal stability make product suitable for catalyst and catalyst carrier.

The new alumina is manufactured by a controlled calcination of beta trihydrate. Principal constituents are eta alumina and alpha monohydrate, and the final product does not contain the usual chi and gamma aluminas. The initial crystal structure, nature of the activation

process and spherical form are among the factors which result in a superior active alumina product.

Company explains that the new product's thermal stability is better than granular's, about on a par with gel's, because there's less rapid breakdown of material (from eta to gamma) at elevated temperature. Hence product retains activity longer.

—Kaiser Aluminum & Chemical Corp., Oakland, Calif. 108B

Alkylmorpholines

Catalysts for urethane foams, stabilizers for chlorinated hydrocarbons.

N-methylmorpholine and N-ethylmorpholine are now available. Major areas of application for these alkylmorpholines are: As catalysts in the preparation of rigid, semi-rigid (or elastomeric) and flexible urethane foams; as stabilization agents for chlorinated hydrocarbon solvents.

In addition, the two products are suggested for use in the preparation of self-polishing waxes, oil emulsifiers, corrosion inhibitors, and pharmaceuticals.

—Jefferson Chemical Co., Houston, Tex. 108C

Newsworthy Chemicals

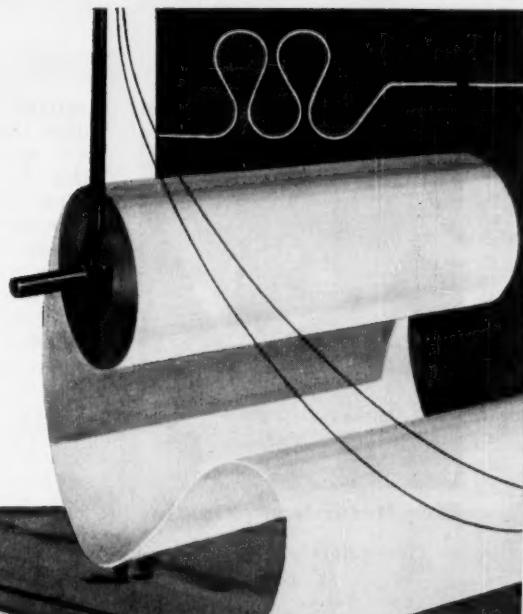
**Page Number is also
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on stream at Aberdeen

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The big news in sodium chlorate is TRONA's new electrochemical plant, now on stream at Aberdeen, Mississippi. This latest AP&CC facility provides faster and better service to the South's growing pulp and paper production centers, as well as further assurance of dependable sodium chlorate supply for other important markets in such fields as agriculture, uranium ore processing and solid propellant fuels. Aberdeen's readily expandable, initial capacity of 15,000 tons per year, added to the NaClO₃ production capability of Trona's Henderson, Nevada, plant makes American Potash & Chemical Corporation the largest domestic supplier of sodium chlorate...capable of meeting *all demands* from expanding commercial and military users. *Further information on Trona's sodium chlorate service and production capabilities at Aberdeen is available from your nearest AP&CC branch office.*

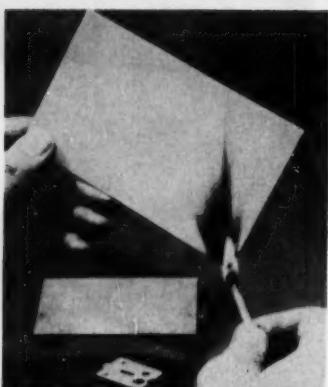


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THORIUM • CERIUM • RARE EARTHS • and other diversified chemicals for Industry and Agriculture*



Fire-Retardant Plastic

Immediately after lighted match is removed, flame goes out.

A new grade of laminated plastic for electrical applications where humid conditions are encountered remains rapidly self-extinguishing after five ignitions. It absorbs only 0.35% water after a 24-hr. immersion.

Made from cellulose paper impregnated with epoxy resin, it is called Dilecto XXP-31EFR. Copper-clad sheets, called Di-Clad 31EFR, are also available.

It is suggested as insulation for computers, radios, telemetering equipment and guidance equipment, all of which require permanent flame-retardant properties.

It features excellent cold-punching qualities, is much lighter than epoxy glass-fabric base laminates. Thickness range is from 0.015 through 0.25 in. in sheet sizes of 38 in. by 42 in., and 38 in. by 38 in. Di-Clad 31EFR metal-clad material is the same basic material with one or two ounce copper foil on one or both sides.—Continental-Diamond Fibre Corp., Newark, Del. 110A

Fire-Resistant Foam

Rigid urethane foam bids for use over wide temperature range.

Rigid fire-resistant polyurethane foam possessing unique properties can now be made from polyester resins newly

available in commercial quantities. Hetrofoam, a series of new resins based on Hooker's HET Acid, can produce urethane foams said to combine these properties: permanent high-level fire resistance, high strength, superior high temperature strength, dimensional stability at high temperature and humidity, low thermal conductivity, excellent adhesion, resistance to water absorption and low moisture permeability, and outstanding permanence.

Foams made from Hetrofoam resins are expected to be especially for rigid structural purposes. They should find important markets in slab or formed industrial insulation, particularly in applications where broad range performance from extreme low temperatures up to 350 F., fire resistance, and a high degree of permanence are important factors.

The new class of closed-cell foams made from Hetrofoam is prepared in a wide range of densities and strengths by the one-shot batch process, making them among the most economical foams to put in place. First two resins offered are Hetrofoam 10 and Hetrofoam 14. Using the truckload or carload drum price of 75¢/lb. for either, and with toluene diisocyanate at 85¢/lb., foam raw material costs are about 78¢/lb. for low density foams of 2½ lb./cu. ft. This compares with costs of \$1 or more per pound for most high quality conventional foam systems.—Hooker Chemical Corp., Niagara Falls, N. Y. 110B

BRIEFS

High-temperature graphite, Grade 469, is the result of special treatment that inhibits oxidation to assure maximum performance between 1,000 and 1,200 F. It will not bleed out, is self-lubricating, will not seize or fuse and is unaffected by most chemicals and gases. Uses: main bearing oil seals on turboprop engines, bearing inserts in turbine blade pitch adjusting mechanism.—Stackpole Carbon Co., St. Marys, Pa. 110C

Liquid dicarboxylic anhydride,

Beta-S, now available in development quantities, is particularly useful in curing epoxy resins. For impregnating, potting, casting, laminating, systems cured with it possess high compressive and flexural strengths. Dimethyl substituted butenyl tetrahydro phthalic anhydride, it has potential as an intermediate for surfactants, lubricant additives, corrosion inhibitors, dyes, fungicides and inks.—Heyden Newport Chemical Corp., New York, N. Y. 110D

Krypton 85 supply for civilian use has been increased to 100,000 curies/yr. It is finding increasing use for activating phosphors in self-luminous light sources and proved its potential for many types of safety markers. It excels naturally-occurring alpha-emitting radium and polonium because it is cheaper, easier to work with, causes less deterioration of the phosphor than alpha particles from radium and polonium.—Atomic Energy Commission, Washington 25, D. C. 110E

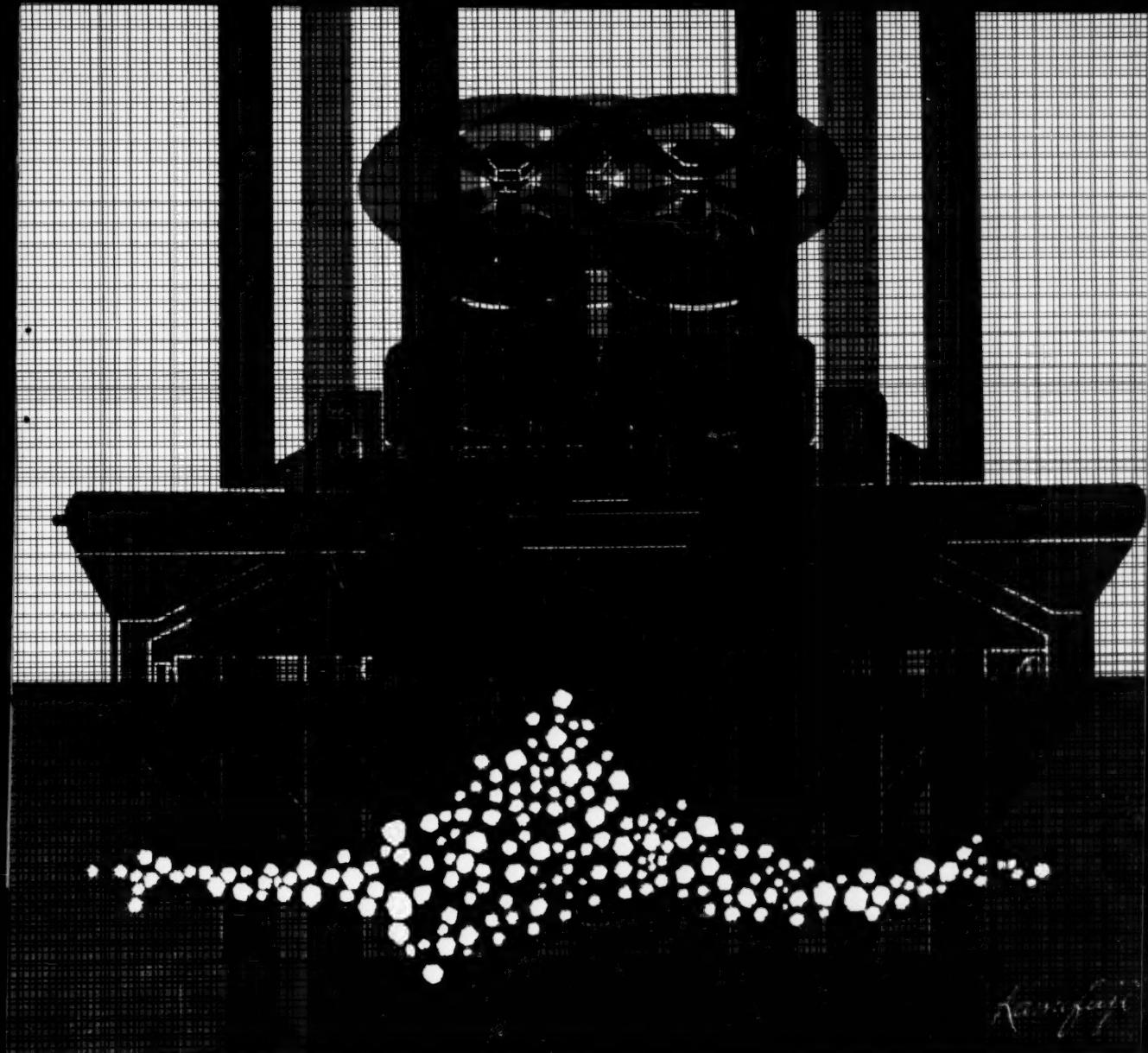
Freon expanded urethane foams for low temperature insulation have been produced with K values of about 0.1. This value is the result of using a new Lockfoam polymer. Foams produced by using Freon in typical polyester resin have K values between 0.15 and 0.18. K factor of typical urethane non-Freon blown foam is about 0.25 to 0.28.—Nopco Chemical Co., North Arlington, N. J. 110F

For More Information . . .

about any item in this department, circle its code number on the

Reader Service

postcard (p. 235)



Vibrating screening machines at Morton plants segregate salt particles into different grades prior to packing and shipment.

Only Morton offers salt service to industry everywhere in America

Morton, the only nation-wide salt company, has salt sources, sales offices and warehouses from coast to coast. This means Morton can offer you complete salt service whether you have just one plant or several plants in different states.

To tailor-make salt to meet all the various needs of industry, Morton starts with high purity salt from one of its sources. With the aid of gigantic refining, drying and screening equipment, plus constant quality checks, Morton can produce and package salt to meet exacting specifications for any user—from tremendous textile mills to small candy companies.

Morton produces nearly 100 different grades of salt for industry. Morton delivers salt by boat, barge, truck and rail. This means you can get fast delivery on a bag to thousands of tons, anywhere in the country.

Morton sales representatives are backed by the services of their own ultra-modern salt research laboratory—the most complete laboratory of its kind in the world. This means you can get complete technical assistance on any problem relating to salt. This service help alone may be worth thousands of dollars to you every year.

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COOLING TOWER DRIVES



... by Philadelphia Gear

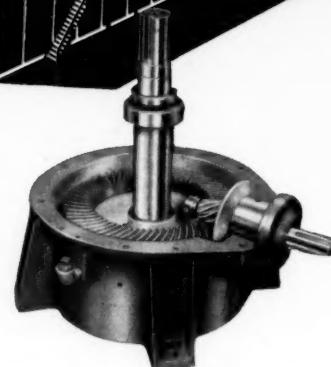
... easily meet the growing need for
larger fans and higher load requirements

Modern Cooling Towers and air-cooled heat exchangers require reducer drives which are engineered for the job. Gears, bearings, housings and bearing supports must meet the severe and varied load requirements of today's heavier fans, higher speeds, increased air thrusts, and more extreme atmospheric and temperature conditions.

Fans should be designed for quick and easy mounting, directly on output shafts. Unit design should allow space for close coupling of motors where this is desired. Generous service factors are necessary to meet momentary overload situations. Careful design for rigid alignment of all components, is important to assure proper installation, and long, trouble-free service life. Lubrication systems must insure maximum protection with a minimum of maintenance.

To meet these stepped-up, modern requirements, Philadelphia Gear has designed a new series of bevel, spiral-bevel and worm gear cooling tower drives. Each is built for a specific type of service, and is available in a complete range of sizes and capacities.

Philadelphia Gear Cooling Tower Drives are in service around the clock—all over the world. For complete details please request Catalog CT-591.



- Maximum Efficiency ... 97% - 98% with minimum heat loss.
- Precision generated Spiral-Bevel Gears, case hardened for long service life.
- Heavy duty housing construction.
- High dome permits mounting fan directly on unit, with ample clearance below fan blades.
- Oversize bearings insure trouble-free operation. Positive splash lubrication provides oil both for bearings and gears.
- Rugged . . . dependable . . . economical Reducer meets all AGMA standards.

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Photo by Mansfield and Cox. Courtesy of Flower Grower, The Home Garden Magazine

The Chemical Engineer tends a 75,000,000-acre garden

Fertilizers, insecticides, seed and soil treating agents, weed killers... aids to the modern gardener created by the Chemical Engineer's technology.

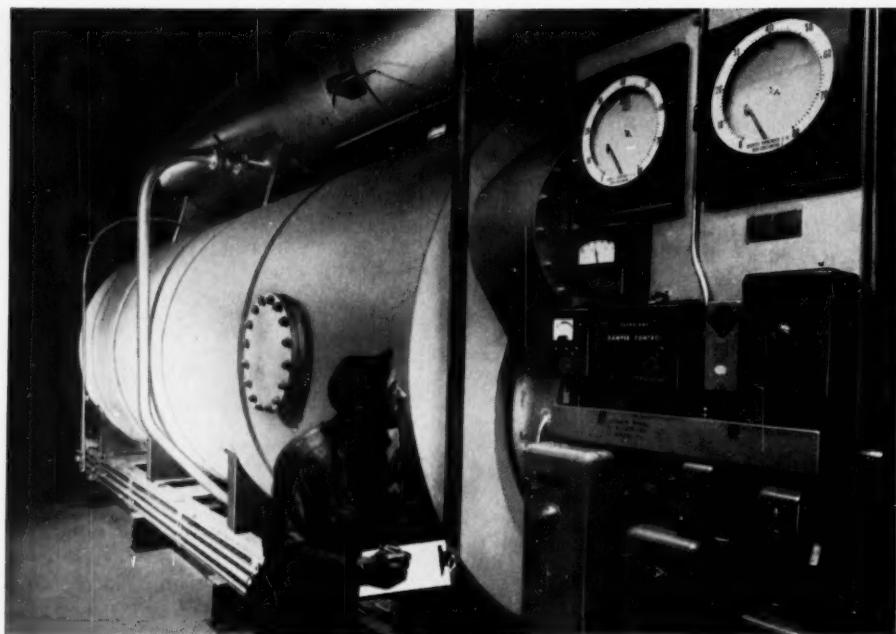
The complex, multi-billion buying chemical process industries — from drugs and dyes to plastics and fertilizers — are tied together by their common dependence on chemical processes and techniques, similar equipment and raw material needs... and the ever-present chemical engineer who makes them work. He designs and builds the plants, develops the products and processes and makes them pay. Naturally his voice is heard at every point in the buying procedure.

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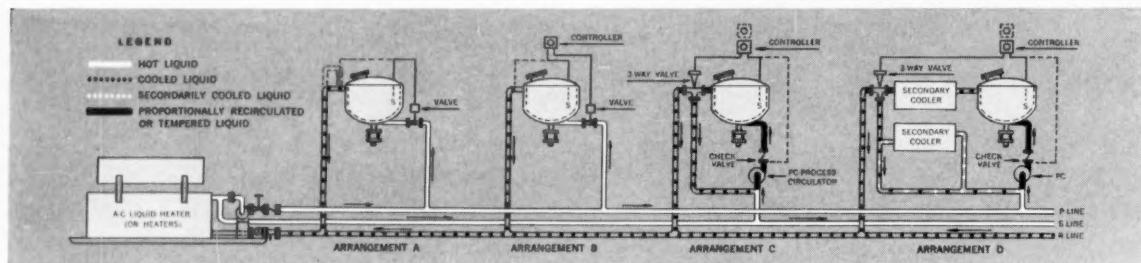


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There are no complicated start-up or shut-down procedures with the A-C Liquid Heater. The system operates automatically, with only monitoring of instruments required.

Low-Pressure, Automatic ALLIS-CHALMERS Liquid Heaters Deliver INDIRECT PROCESS HEAT UP TO 650° F.



Schematic diagram shows various arrangements for delivering automatic, accurately-controlled heat. Any number of vessels, in any arrangement, can be used at the same time with one or more A-C Liquid Heaters.

Where close, automatic temperature control is essential, Allis-Chalmers Liquid Heaters generate and deliver indirect processing heat up to 650° F. The system *operates at atmospheric pressure*, is thoroughly stable, flexible, fully automatic. A-C Liquid Heaters have recently been installed on:

- 5,000-gallon jacketed kettles requiring accurate heat up to 475° F. Jacket pressures are less than 10 psig in fully-automatic operation.
- Jacketed pumps, lines and fittings for transporting viscous materials.

• Continuous curing of molded plastics in immersion bath heated to over 500° F.

• Storage tanks and railroad cars.

Eight models are available in ratings up to 10,000,000 BTU/hour. Initial installation cost is usually less than one cent per BTU per hour of gross heat load. A-C Liquid Heaters will not air-lock, vapor-bind or flood, and explosion hazards are eliminated.

For further information and product bulletins on the Liquid Heater, contact your nearest A-C office, or write Allis-Chalmers, Hydraulic Division, York, Penna.



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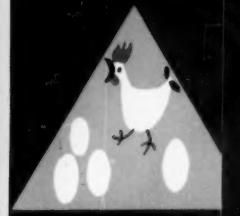
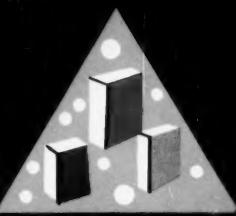


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PILOT PLANT SPRAY DRYERS

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Why settle for less-than-perfect blending? when you can put **CONTROLLED DISPERSION** to work for less than \$1500.00*

If you mix dry solids or semi-solids in *any* quantity, an investment of only \$1475.00 in this $\frac{3}{4}$ cu. ft. intensive mixer may show you how to save *four times that much* in waste, rejects and reprocessing costs—in the next year or less.

The "LF" model of the Simpson Mix-Muller is manufactured to the same exacting standards as production size Mix-Mullers. It was designed to be used in lab or pilot plant as an economical means of establishing standards for batch composition; testing new formulations and for checking quality control on production mixing operations.

Experience shows, however, that it is most frequently used by prudent processors who want to evaluate the benefits of controlled dispersion *for themselves*, before they invest in full-scale mulling equipment. The fact that *few* "LF" machines are ever disposed of but *many* enthusiastic converts to the mulling principle of controlled dispersion are made, is evidence that the "LF" is a wise and *useful* investment for small, or large scale operators.

Write for a list of users of the versatile "LF" Mix-Muller... Or, for details on a confidential *mulling survey* of your product conducted under the strictest laboratory conditions.

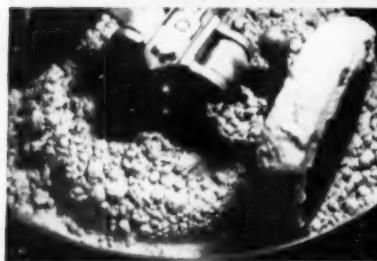
See our advertisement pages 1263-1266 C E C for more details

SIMPSON MIX-MULLER® DIVISION

National Engineering Company
636 Machinery Hall Building • Chicago, Illinois

P-259

HOW MULLING gives you controlled dispersion for better blends:



GOING: Mix is wetted, dispersion of coating media begins as lumps form.



GOING: Smearing, spatulate action breaks up lumps as mulling action disperses moisture.



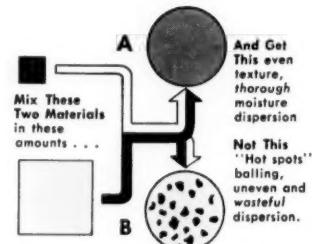
GONE: Agglomerates almost gone as blending nears completion. Mix is homogeneous, thorough.



- Unit, ready to go, as above, FOB Chicago \$1475.00*
- Same with #302 or 304 stainless steel pan and all interior mixing components FOB Chicago \$2850.00*

*Prices quoted are for domestic shipment only.

Model "LF" Mix-Muller has capacity of $\frac{1}{4}$ to $\frac{3}{4}$ cu. ft. Comes equipped with 1 HP motor and starter, V-belt drive, removable dust hood, crib and muller scrapers, liquid additions funnel, integral base for bench mounting and 4 pipe legs for floor mount. No foundations necessary. Has machined crib and mullers; discharge is automatic, by bottom door.



Here's how controlled mulling works:

Diagram shows comparative results of blending a minute amount of one material with large amount of another material in (A) MIX-MULLER and (B) conventional mixer. Savings in raw material, reprocessing time and quality of finished product are the outstanding rewards of mulling your product.





In this revolving drum, tablets are coated with syrups, powders and waxes. Because the drum is Stainless Steel, it takes only a few seconds to clean it with steam jets.

Stainless Steel equipment protects 100% product purity

at Eli Lilly and Company, Indianapolis, Indiana

"Science has created hundreds of lifesaving and pain-relieving formulas," says an official of Eli Lilly and Company. "But unless these formulas are produced in medicines that are 100% free of every possible contamination, they could do more harm than good. We make millions of tablets every month, for instance, and we must be positive that the ingredients are pure for every single one. That's why we use nothing but Stainless Steel for so much of our equipment."

"Stainless guarantees product purity. It resists corrosion. It's durable and hard, won't chip or crack. It has a smooth, dense surface that is easy to keep clean—and it is not harmed by the cleaning agents we must use. True, we paid more to install Stainless Steel, but it will save money in the long run because we don't have to worry about replacements."

Eliminate product contamination in your plant. Start by examining your equipment to see if it's a threat to cleanliness. Replace it with Stainless Steel. And specify USS Stainless Steel for service-tested quality.

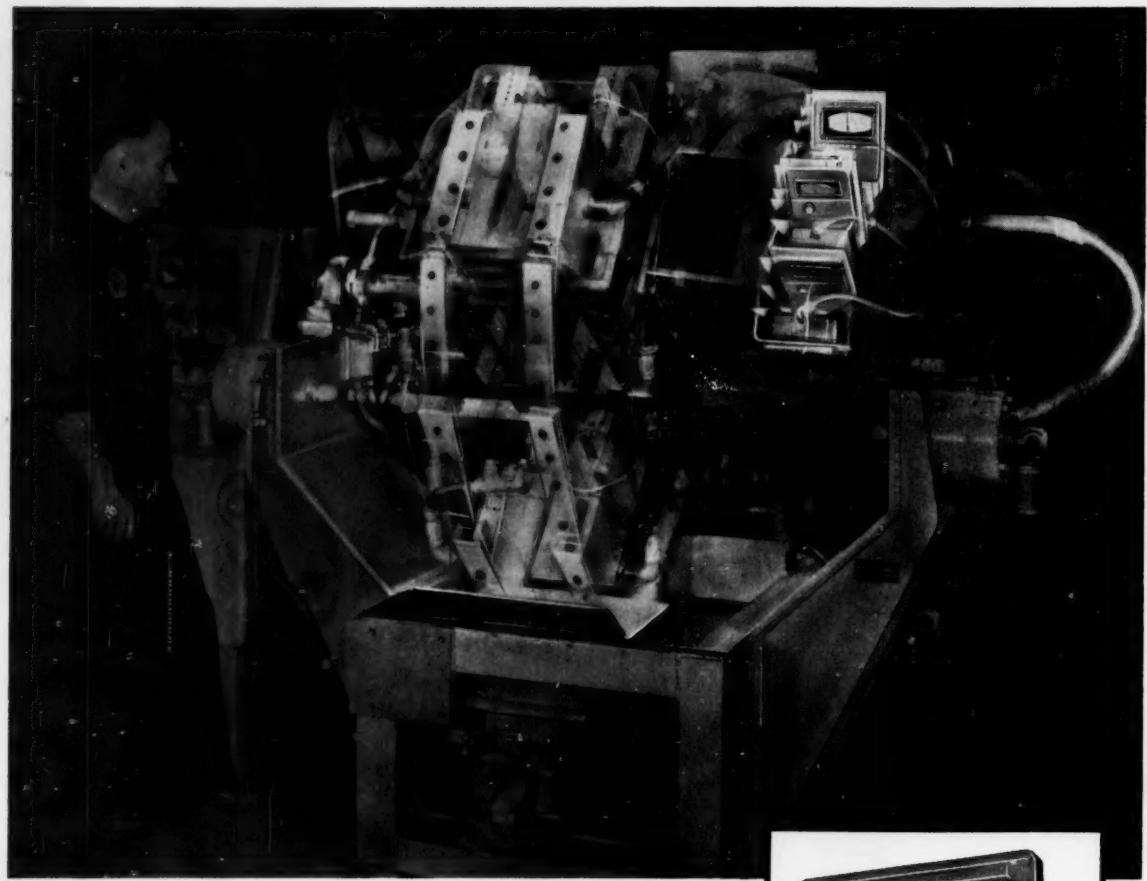
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Columbia-Geneva Steel—San Francisco
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Supply—Steel Service Centers
United States Steel Export Company



United States Steel



A Partlow Model MFS indicating controller is shown in action in this "multiple exposure" shot of a Holo-Core Automatic Molding Machine manufactured by Spo, Inc., Cleveland, Ohio.

The Temperature Control Built to **SHRUG OFF SHOCK** 2438 Times a Day

Every working day, the Partlow Temperature Control in this photo takes between 2400 and 2500 solid "roundhouse punches" from the shell-molding machine to which it is attached.

But despite jarring shock and vibration, and a constant barrage of foundry dust, the Partlow goes right on delivering precision control—without letup or breakdown.

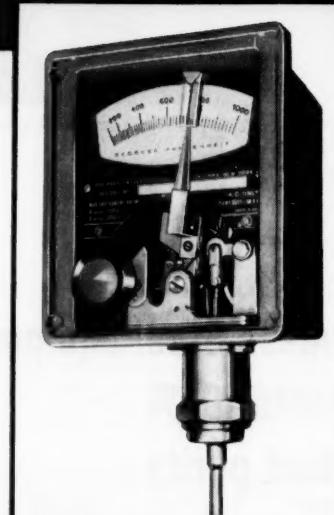
Actually, only a control as simple and rock-solid as the Partlow could withstand this kind of punishment! Because only the Partlow contains no hairsprings, or delicate gadgets.

All Partlow thermal elements of the same range are interchangeable on the job, too. There's no time lost waiting for your control to

come back from the factory. And you get this extra margin of dependability without loss of accuracy. Partlow controls are precise to within 1% of scale in any one of 10 ranges from -30° to 1100° F.

If you use or manufacture equipment within this temperature range, there's a Partlow to fit your application exactly . . . and save you money, too. Available in Pneumatic, Electric or Self-Contained Gas types, in recording, indicating or non-indicating models! To field test any Partlow control . . . or to obtain full details write, The Partlow Corporation, New Hartford, N. Y. Dept. E-459

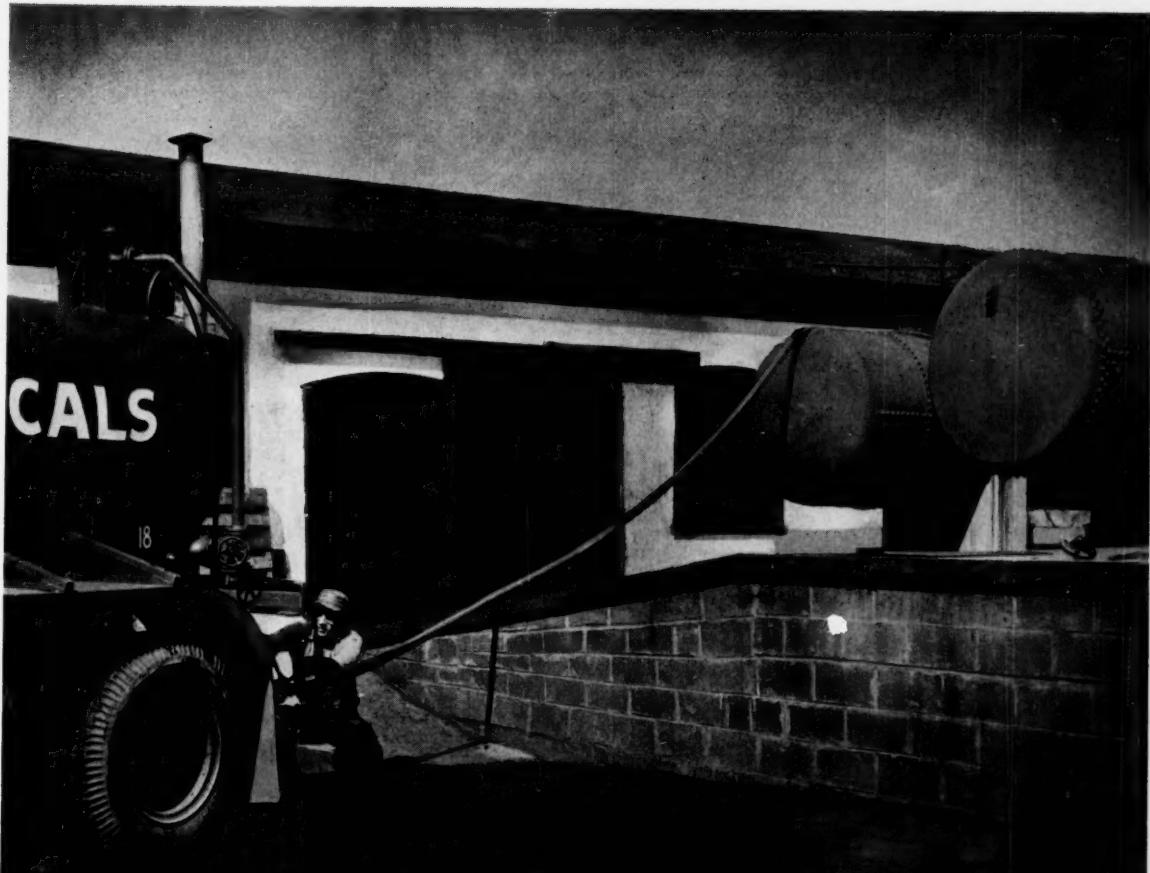
Export: Ad. Auriema, Inc., 85 Broad St., New York 4, N. Y.



A complete absence of gadgets and superfluous parts, as seen in this open view of the new MFS indicating control, explains the Partlow's unique ability to function accurately even under the most severe operating conditions.

You can pay more but you can't buy better than

PARTLOW
TEMPERATURE CONTROLS



Better than any other acid hose we've ever used

After handling many makes of acid hose the chemical operator at this plant has found that Acme-Hamilton acid discharge hose is outlasting the others, remains flexible even when cold, and is highly resistant to weathering. This A-H hose has been in service 2 years conveying 2,000 gallons of commercial sulfuric acid per week.

Acid Discharge Hose

(A) Cover. Tough abrasion and acid resistant rubber. Hose ends are rubber sealed.

(B) Carcass. Multiple fabric plies withstand pumping pressures, provide high degree of flexibility.

(C) Tube. Pure gum; will handle wide range of acids, salts and alkalis. (Can also be furnished with Hypalon® tube for special applications.)

Write Dept. C-1, *Du Pont T. M.

A

B

C

Acme Hamilton

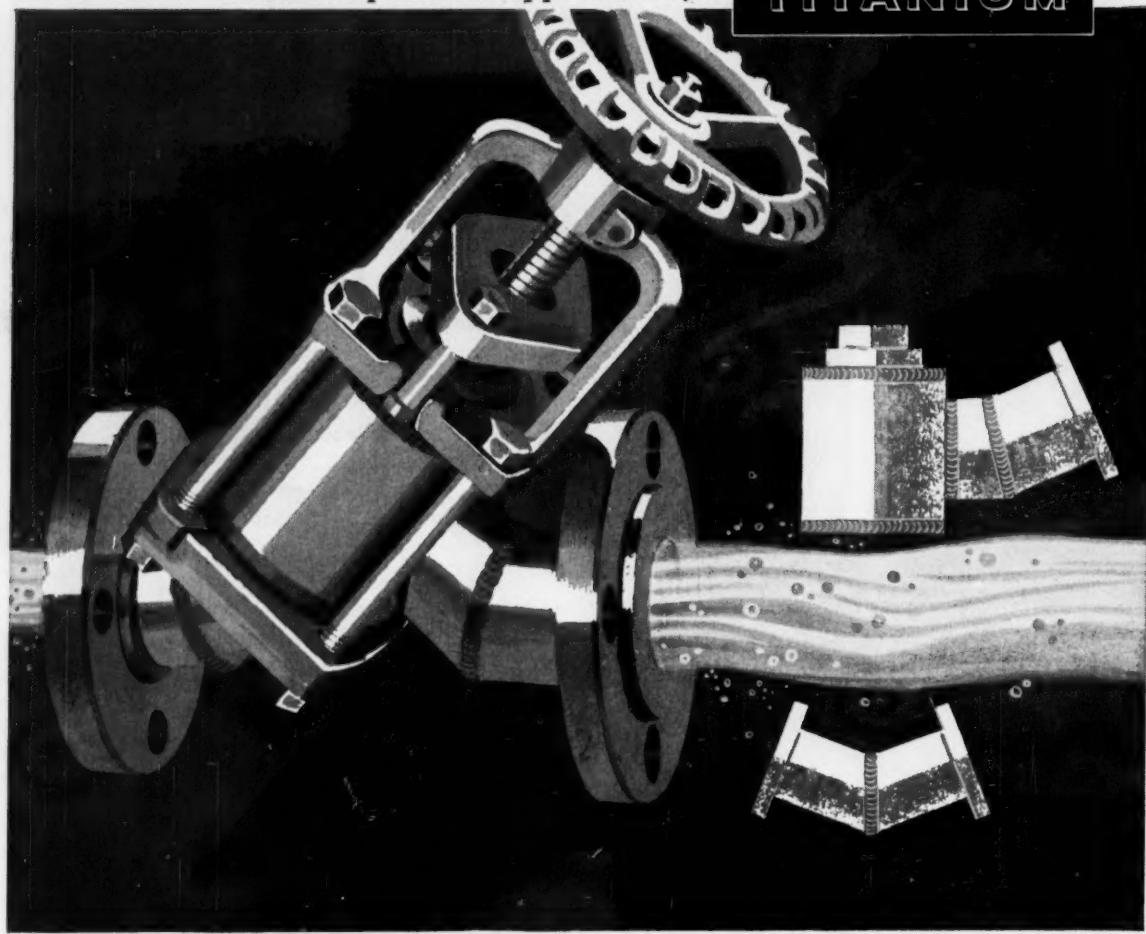
MANUFACTURING CORPORATION, TRENTON 3, N. J.

Divisions: Acme Rubber Mfg. Co. • Hamilton Rubber Mfg. Corp.

ATLANTA • CHICAGO • DETROIT • HOUSTON • INDIANAPOLIS • LOS ANGELES
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Another practical application for

TITANIUM



"CORROSION SPECIALISTS" TURN TO TITANIUM

...for working parts of new **DURCO[®]** valves

The Duriron Company, Inc., manufacturer of "Durco" valves and pumps, specializes in design and manufacture of equipment for corrosive service. Now they're among the first to turn to titanium . . . producing, to order, fabricated valves used in highly corrosive applications. These valves are specially designed for handling hot nitric acid, hot chlorides, organic acids, mixed acids, etc.

In the Durco Type K "Y" valve, shown above, all metal parts in contact with corrosive solutions are Mallory-Sharon titanium. Mallory-Sharon engineers worked closely with Duriron designers on welding and forming

techniques for the new valves. Mallory-Sharon titanium mill products are also being used in a Durco plug valve and a new line of corrosion resistant "Durcopumps".

For help in applying titanium's unusual corrosion resistant properties to your processing equipment, write for Technical Data Sheet on *Titanium Valves for Chemical Service*. Please address: Commercial Market Development, Department B, Mallory-Sharon Metals Corporation, Niles, Ohio.

MALLORY M S SHARON

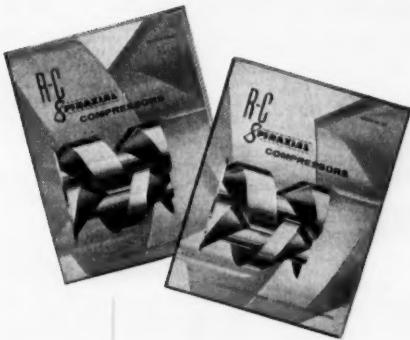
MALLORY-SHARON METALS CORPORATION • NILES, OHIO



Integrated producer of Titanium • Zirconium • Special Metals

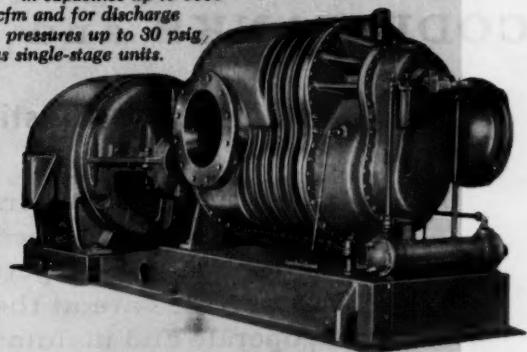
HIGHER RATINGS

Increase Efficiency of R-C Spiraxial Compressors

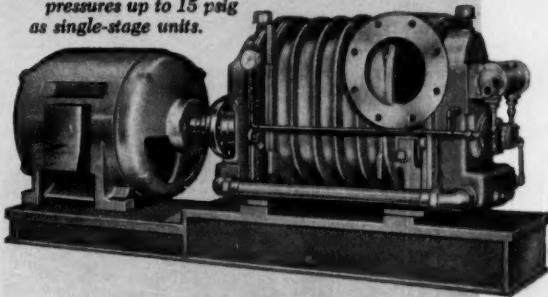


For additional data, please refer to pages 565-568 in Chemical Engineering Catalog, our section in Mechanical Catalog or write for Bulletins LAH-158 and LAL-458.

R-C Type LAL Spiraxial Compressors are available in capacities up to 5000 cfm and for discharge pressures up to 30 psig as single-stage units.



R-C Type LAH Spiraxial Compressors are available in capacities up to 12,000 cfm and for discharge pressures up to 15 psig as single-stage units.



The famous R-C Spiraxial® Compressor is now offered in two pressure ranges — both with increased efficiency and higher ratings.

The Type LAL for pressures to 30 psig has been serving efficiently and economically in a wide variety of applications. Its *efficiency* and *economy* have been proved by 24-hour service for months on end at oil refinery installations. The unit has helped increase throughput to such an extent that one-year's run will pay for the installation.

With the new lower-pressure Type LAH for pressures to 15 psig, the efficiency and economy of R-C Spiraxial Compressors can now be gained in many new applications. Its *dependability* has been proved by its use in nuclear-powered submarines for ventilation exhaust and ballast blowing. Either Type LAL or LAH can be employed in parallel operation to increase capacities indefinitely.

The ability of Spiraxial Compressors to deliver oil-free, uncontaminated air or gas makes them ideal for such applications as aeration and agitation of fermentation vessels, pneumatic conveying, catalyst regeneration, process oxidation and many others.

The Spiraxial design which makes possible this broad range of applications is the result of R-C's specialized experience of more than 100 years in the design and application of air and gas handling equipment.



ROOTS-CONNERSVILLE BLOWER

DIVISION OF DRESSER INDUSTRIES, INC.

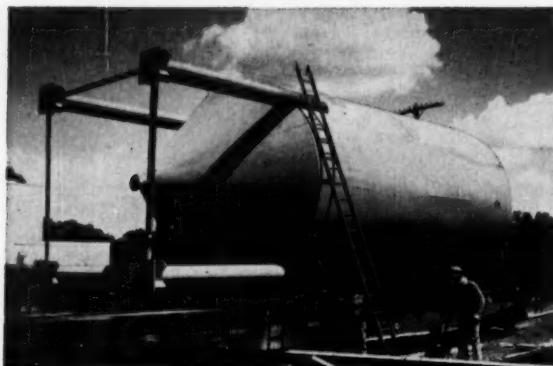
495 Illinois Ave., Connersville, Indiana. In Canada—629 Adelaide St., W., Toronto



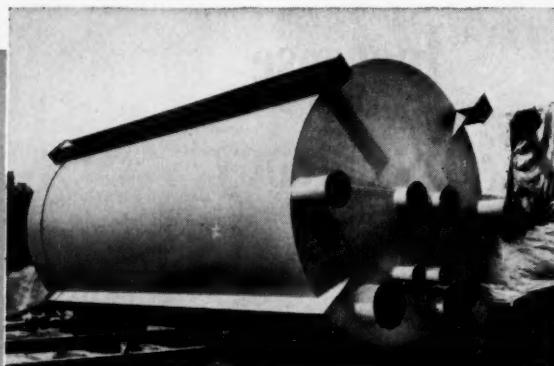
In Custom Fabrication of CODE TANKS and PRESSURE VESSELS

there is no substitute for *Experience*

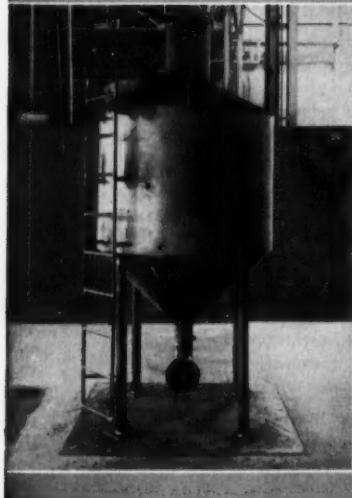
Modern Welding offers a wealth of experience in custom fabrication. Our well equipped strategically located plants serve chemical processing and petroleum industries throughout the world. Our facilities are at the disposal of the men who design, construct, operate and maintain processing plants.



Sludge Settler tank for petrochemical plant is the first in this revolutionary new design.



Dual purpose phenolic-lined polyethylene storage tank with structural reinforcements.



Calibration and prover tank for measuring the accuracy of pipeline crude oil meters.



Air receiver tanks for compressor stations. Pressure tested in 450 lbs. of hydrostatic pressure conforming to A.S.M.E. 1952-A code. Each X-ray tested.



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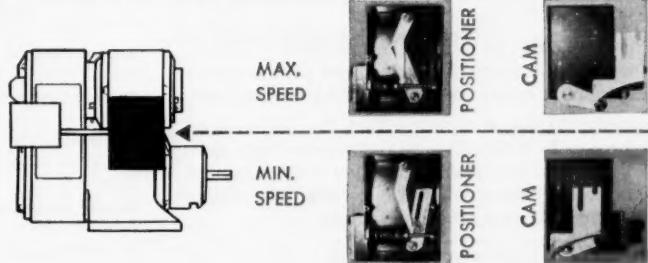
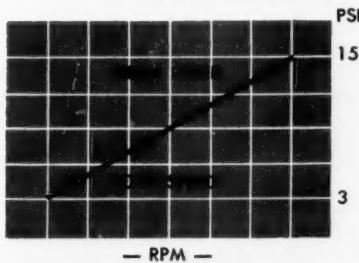
REEVES

AUTOMATIC PROCESS CONTROL
with
Vari-Speed Motodrives

AIR SIGNAL FROM
PROCESS TRANSMITTER
3 TO 15 P.S.I.
INSTRUMENT AIR SIGNAL

PLANT AIR SUPPLY

**Sensitive Speed Reaction to Controller Signals
... Straight Line Variable Speed Output**



- REEVES AIRtrol, in an open or closed loop system, automatically and continuously corrects operating speeds to compensate for variations in materials or energy (i.e. temperature, liquid level, density or flow).

As the final control element, the pneumatically-controlled Motodrive assures sensitive and stable control throughout the speed range.

Linear speed output is a result of the exclusive cam de-

sign. The AIRtrol responds to a 3 to 15 p.s.i. pneumatic signal, and is adaptable to all standard process instrumentation.

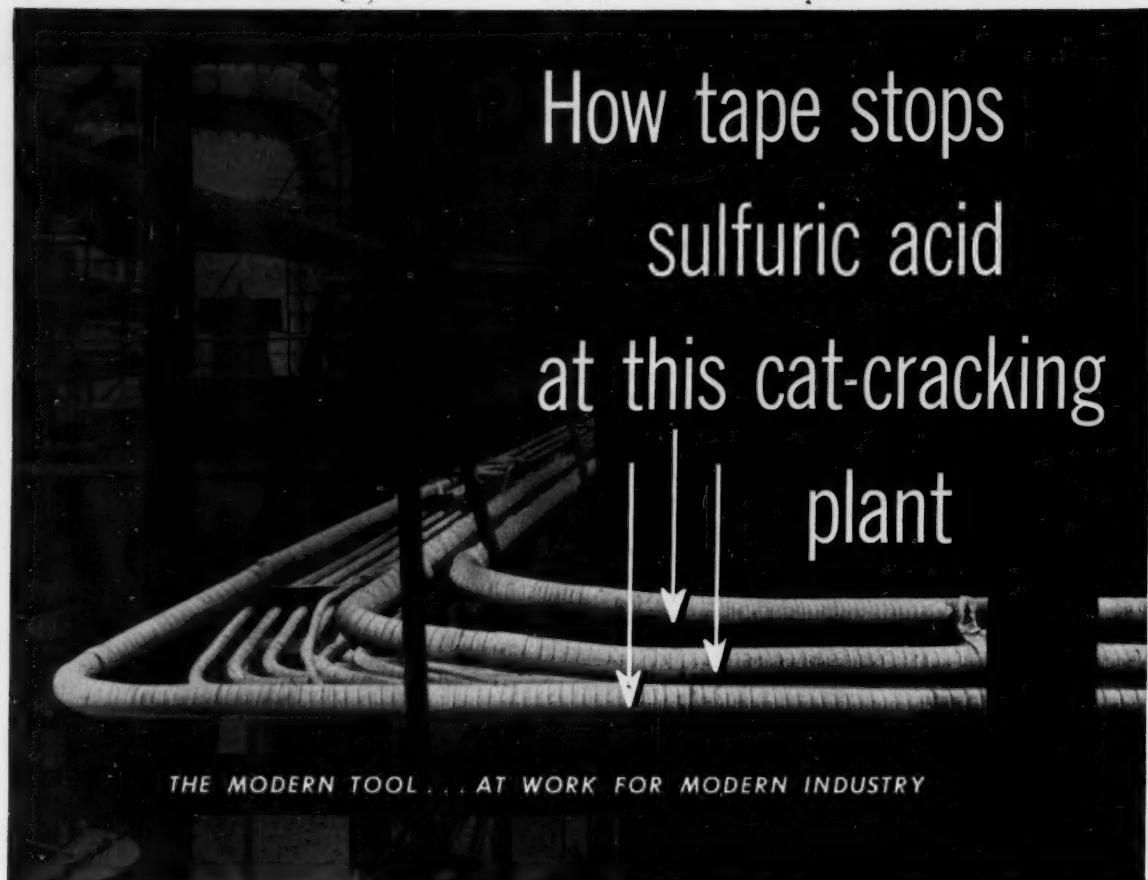
The AIRtrol is available on all REEVES Motodrives . . . hundreds of assemblies from $\frac{1}{4}$ through 40 hp., 2:1 through 10:1 speed range, and 1.7 through 4660 rpm.

For examples of AIRtrol in process control systems, write Dept. CE 39a for AIRtrol Instrumentation Data Sheets.

VARI-SPEED MOTODRIVE
VARI-SPEED MOTOR PULLEY
VARIABLE SPEED TRANSMISSION

REEVES PULLEY COMPANY
Division of **RELIANCE ELECTRIC AND ENGINEERING CO.**
COLUMBUS, INDIANA
In Canada: Reeves Drives • Toronto • Montreal





How tape stops sulfuric acid at this cat-cracking plant

THE MODERN TOOL . . . AT WORK FOR MODERN INDUSTRY

FIVE YEARS UNDER THESE HIGHLY CORROSIVE CONDITIONS PROVES THAT POLYKEN PROTECTION WORKS . . . TO TRIM COSTS

Look in on one of the world's largest fluid catalytic cracking units. A maze of conduit and pipe exposed to an extremely corrosive sulfuric acid atmosphere.

Formerly, these structures had to be painted every three or four months. Maintenance costs were excessive. Then, five years ago, they were wrapped with Polyken Protective Tape Coating. They have needed practically no attention since.

INERT POLYETHYLENE

The reason is that Polyken takes amazingly inert polyethylene and makes it into a tape coating with all these properties.

- tough and elastic
- unplasticized, non-drying film
- doubly thick adhesive to seal all voids
- far higher adhesion for a true bond to pipe surface
- lower water vapor transmission rate
- higher electrical insulation resistance
- better cold weather handling and durability

Check the savings. Contact the Polyken distributor in your area.

Atlanta, Georgia: Steele & Associates, Inc.

Chicago, Illinois: Sales Engineering Inc.

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St. Louis, Missouri: Shutt Process Equipment Co.

San Francisco, Calif.: Incandescent Supply Co.

Seattle, Washington: Forwest Corrosion Control Corp.

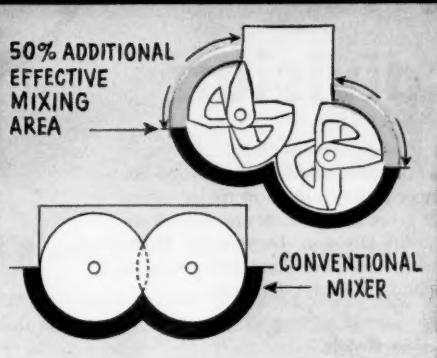
Seattle, Washington: Pacific Water Works Supply Co.

Polyken®

Experienced in modern
PROTECTIVE COATING

THE KENDALL COMPANY
Polyken Sales Division

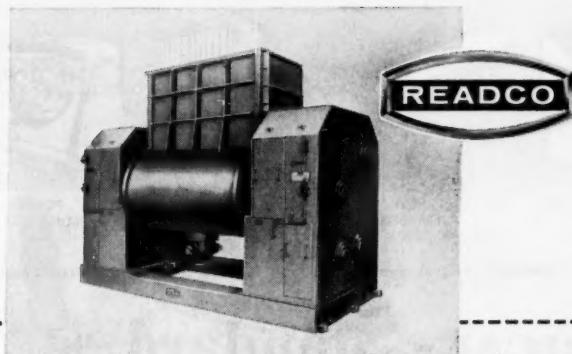
**take this unique
design...
PRESTO!
a much
faster mix!**



with Readco's unique split-level bowl:
complete dispersion, shorter cycle, lower cost

The special design of this Readco mixing bowl provides a 50% greater effective mixing area. Overlapping sigma arms operate at minimum clearance from the shell, prevent build-up of materials, speed dispersion. The design also permits maximum heat transfer from the jacket.

You'll get complete dispersion, consistent mixing, in substantially shorter cycles. Working capacities range from 150 to 900 gallons. Write for complete information.



Whatever the mixing job: a READCO mixer!

See this mixer featured in our exhibit of processing equipment at the New York Chemical Exposition, December 2-6, Booth 162

READ STANDARD

York, Pennsylvania

**A Division of
Capitol Products Corporation**

AMERICAN-Standard INDUSTRIAL DIVISION

AMERICAN BLOWER • ROSS • KEWANEE

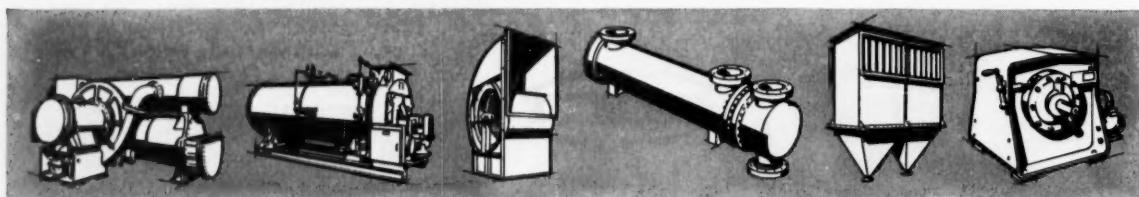
To serve you better we created a new division

Now you can benefit from the combined engineering backgrounds and product lines of three American-Standard* Divisions — American Blower, Ross Heat Exchanger, and Kewanee Boiler — consolidated into one organization under a new name!

Here is one-source responsibility for quality

and performance in equipment that is designed, engineered, and manufactured to work together . . . with engineer-staffed offices in major cities. Bulletin B-5829 gives all the facts on: American-Standard Industrial Division, Detroit 32, Michigan. In Canada: American-Standard Products (Canada) Limited, Toronto, Ontario.

One-source responsibility in all six major fields



AIR CONDITIONING
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HEATING

VENTILATING

HEAT
TRANSFER

DUST
COLLECTION

POWER
TRANSMISSION



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AMERICAN-Standard INDUSTRIAL DIVISION

AMERICAN BLOWER PRODUCTS • ROSS PRODUCTS • KEWANEE PRODUCTS



The technical
assistance
you need!

It's part of every shipment of Pittsburgh Activated Carbon

WHETHER you're planning a completely new adsorption system . . . or trying to get better results from your existing system . . . Pittsburgh stands ready to offer you "in-plant" technical service to help increase adsorption efficiency, reduce costs and develop higher product quality.

By working right along with your engineers, a Pittsburgh technical representative will be able to evaluate

and advise on improvements in your present system . . . or help you set up a small scale laboratory column to prove how Pittsburgh Granular Carbons can dramatically increase the efficiency of your adsorption system.

Call or write today. An experienced Pittsburgh technical representative will be glad to discuss your adsorption problems . . . without obligation.



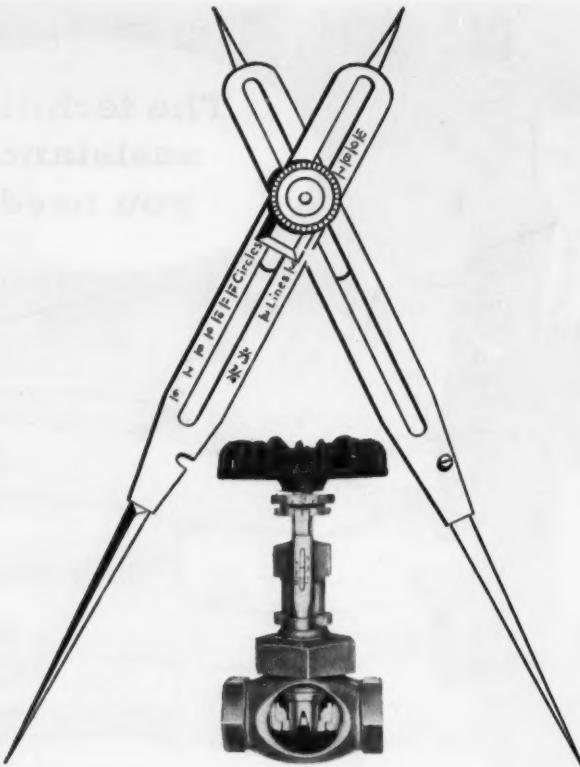
FREE BOOKLET

Describes types and various applications of Pittsburgh Activated Carbons, in both liquid and vapor phase adsorption. For your free copy, write to Dept. H.



WSW-7801

ACTIVATED CARBON • COAL CHEMICALS • PLASTICIZERS • PROTECTIVE COATINGS • PIG IRON • COKE • FERROMANGANESE • CEMENT



PROPORTIONER

controls flow to save for you

The V-port disc in all Hancock "Flocontrol" Valves insures proportional flow throughout the entire lift of the stem. They are valves that help you achieve uniform product quality through closer control, save steam and fuel on process work, and cut maintenance costs.

"3 in 1" valve design combines variable orifice with shut-off and micrometer dial and pointer. The valve opening can be set within 1/10 turn of the handwheel—you can duplicate all settings easily, instantly. No shut-off valve required—flow is in a straight line, with separate shut-off seating surface located away from the V-ports.

Hancock "Flocontrol" Valves are available in Bronze and Steel to meet the most demanding services. Ask your industrial supply distributor for details.



Hancock "Flocontrol" valves assure positive pinpoint control—eliminate all guesswork.



HANCOCK "FLOCONTROL" VALVES

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Watertown, Massachusetts
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

Progress Report...

— Urethane solvents
— Alkylene amines
— Gas dehydrating

And now, polyurethane lacquers

Polyurethane lacquers are creating great interest in the surface coatings industry. A properly formulated lacquer produces a coating that is hard and tough... and has excellent resistance to abrasion, corrosion, and weathering. These coatings can be applied by spray or brush and have potential value in almost every consumer and industrial application.

A critical problem in formulating urethane lacquers is the quality of the solvents used. If the urethane reacts with acid or water in the solvent system, carbon dioxide may be formed... thus creating bubbles in the coating.

To meet the high purity solvent requirements for urethane lacquers, CARBIDE is marketing two new acetate solvents—CELLOSOLVE Acetate, 99% (Polyurethane Grade), and Ethyl Acetate, 99.5% (Polyurethane Grade). Water content is kept below 0.05% by weight and free ethanol does not exceed 0.01% by weight. Thus, reactive hydrogen is kept to a minimum.

Here are the complete specifications that must be met before CELLOSOLVE Acetate, 99% and Ethyl Acetate, 99.5% are shipped to you.

	CELLOSOLVE Acetate, 99% *	Ethyl Acetate, 99.5% *
--	---------------------------	------------------------

Purity, % by wt., min.	99.0	99.5
Acidity (as acetic), % by wt., max.	0.02	0.0005
Water, % by wt., max.	0.05	0.05
Free Ethanol, by diff., % by wt., max.	None	0.01
Nonvolatile matter, % by wt., max.	None	0.01
Color, Pt-Co, max.	15	10
Distillation, 760 mm Hg 1 bp, min.	150.0° C.	75.5° C.
Dp, max.	160.0° C.	78.0° C.
Odor	Mild	Esteric, fruity and non-residual

*Polyurethane Grade

For further information, check the coupon for CARBIDE's technical information bulletin on Urethane Solvents.

Reminder to drug makers

Numerous pharmaceutical products can be synthesized from alkylene amines. Solutions of aminophylline, a salt used for treating cardiac ailments, can be prepared from ethylene diamine with theophylline. The ethylene diamine also serves to stabilize the solution.

Antihistamines and imidazoline derivatives, used for treatment of circulatory disturbances, can be obtained by using ethylene diamine and sub-



stituted ethylene diamines as starting materials. Many other types of pharmacologically active agents can be prepared from alkylene amines. More information on these useful CARBIDE chemicals can be found in a new booklet, available now. Check the coupon for your copy.

Gas dehydrating with glycols

Natural gas produced from most wells contains water. Both the liquid phase and the water vapor must be removed in order to prevent the formation of hydrocarbon hydrates which would block gas transmission lines. The easiest and most common way to do this is by passing the gas through a glycol solution.

Both diethylene and triethylene glycols are used to remove moisture from natural gas before it enters the pipeline. Triethylene glycol is also used as a liquid desiccant in small packaged plants at the gas well head to eliminate the need for alcohol injection or line heaters in field gathering systems.

Dehydration units using diethylene

glycol and triethylene glycol have the advantages of low investment cost and simplicity of operation. A further advantage is that glycols are not corrosive to the carbon steel used in gas field equipment. Thus, most glycol units operate without trouble year in and year out.

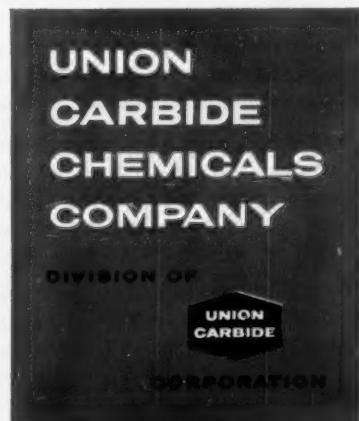
CARBIDE maintains an extensive engineering service group to help natural gas producers get the best possible gas dehydration efficiency with CARBIDE's diethylene glycol and triethylene glycol. As a part of this service, a comprehensive bibliography of articles devoted to improving gas dehydration operations is available. Compiled by CARBIDE, this publication lists every major article on gas dehydration since 1931. To obtain a copy, check the coupon for Technical Information Bulletin F-9289.

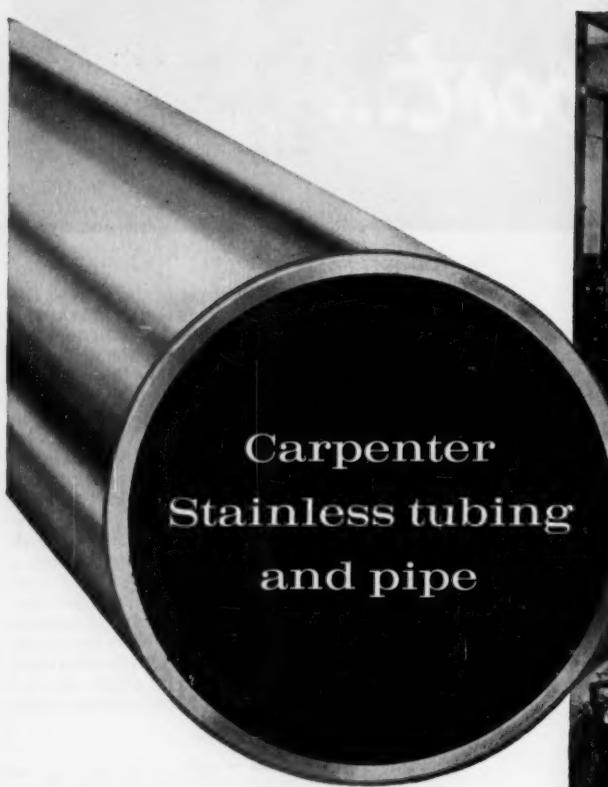
Tear out this coupon. Check the boxes on which you'd like more information, and mail to Dept. H, Union Carbide Chemicals Company, 30 East 42nd Street, New York 17, N. Y.
 Urethane Solvents. Alkylene Amines.
 Bulletin F-9289 (Gas Dehydration).

Name _____
 Company _____
 Street _____
 City _____ Zone _____
 State _____

And remember, there is a CARBIDE sales office near you where you can obtain the services of a CARBIDE Technical Representative. His wide industry experience is backed both by extensive chemical training and by Technical Specialists.

"Cellosolve" and "Union Carbide" are registered trade marks of Union Carbide Corporation.





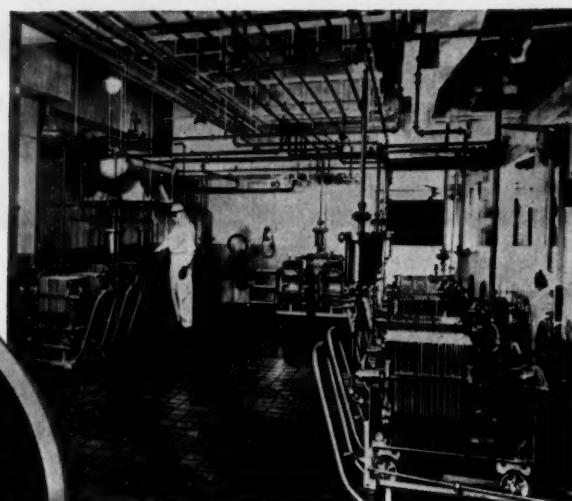
Carpenter Stainless tubing and pipe

**cost
saving assets
to "operating room"
sterility**

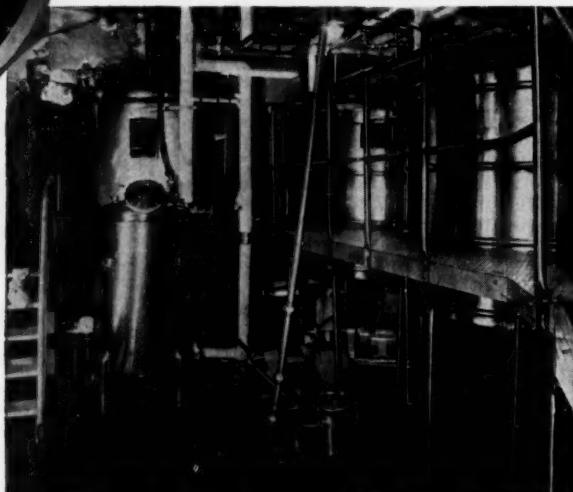
● As transfer piping in processing and packaging operations, as coils in heat transfer units and as protective railings, Carpenter Stainless Tubing and Pipe help the world's leading producer of antibiotics to achieve the optimum sterility required in production areas. Costly maintenance procedures formerly required to meet rigid standards of sanitation, product purity and safety are greatly simplified; cleaning is made easier; downtime is reduced.

Wherever corrosion or contamination is a problem, Carpenter Stainless Tubing and Pipe are indicated. You can depend on Carpenter to furnish the grades, sizes, shapes and finishes needed to meet your requirements.

Your Carpenter representative or distributor stands ready to help you improve operations and reduce costs with Carpenter Stainless Tubing and Pipe. Call him in. Ask for our Selecting and Buying Guide, Bulletin TD 120. The Carpenter Steel Company, Alloy Tube Division, Union, N. J.



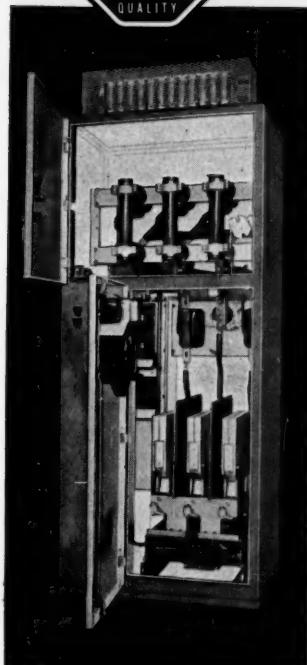
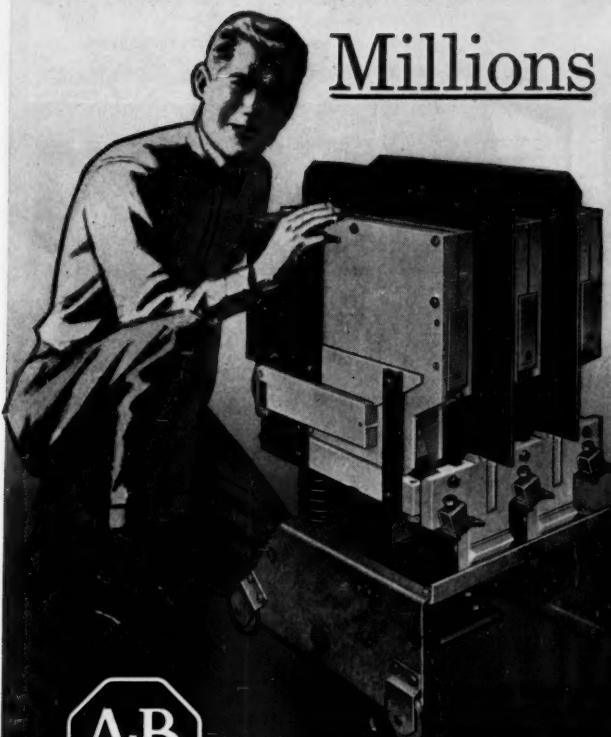
Transfer lines connecting kettles, bulk holding tanks, filter presses and other equipment used in processing and packaging antibiotics are Carpenter Stainless Tubing and Pipe to protect product purity, reduce costs.



*your master key
to cost savings in
chemical processing*

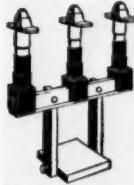


You Can Expect Millions of Trouble Free Operations with Allen-Bradley High-Voltage Air Break Starters

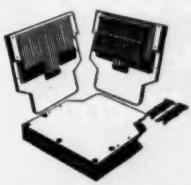


For the petroleum and chemical industry—where tough jobs are the normal routine—there's nothing to match these A-B high-voltage starters. Their simple solenoid contactor—with only ONE moving part—assures an operating life that will amaze even the most skeptical. The silver alloy contacts are always in perfect operating condition—no filing or "dressing" is necessary.

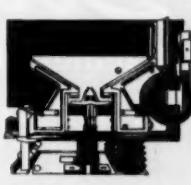
These new air break starters are made for all types of motors and for every service—up to 1500 hp, 2300 volts; 2500 hp, 4600 volts. Get the complete story. See how it is possible for these A-B starters to take the punishment of frequent switching, jogging, and plugging. Send for Publication 6080.



Only One Moving Part
Simple solenoid design eliminates trouble-causing pins, pivots, and flexible jumpers.



Faster Arc Suppression
New blowout design and unique arc chute. Chutes are molded from a new arc resistant material.



Double Break Contacts
of silver alloy never need maintenance. Vertical motion assures uniform contact pressures.

Allen-Bradley Co., 1337 S. First St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

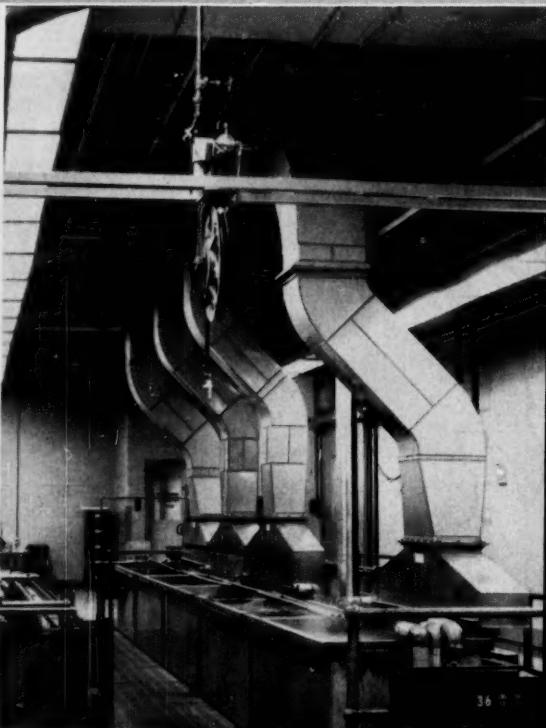
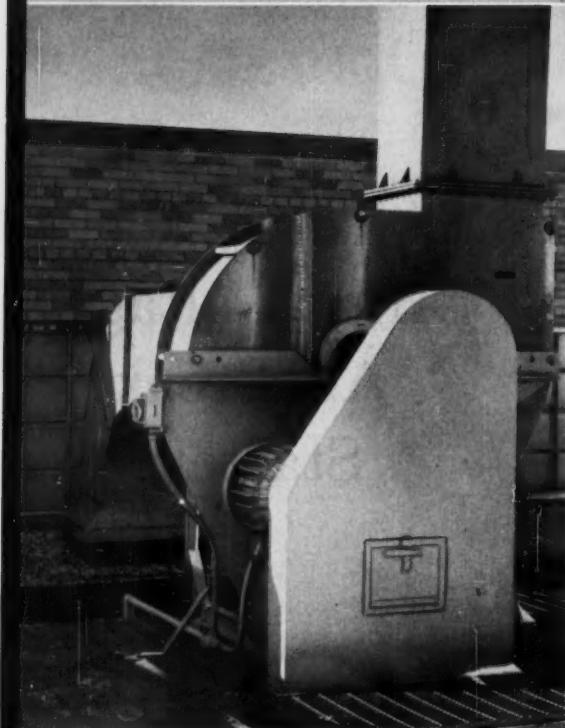
Bulletin 966 high-voltage air break across-the-line synchronous motor starter in NEMA Type 1 enclosure. All A-B high-voltage starters are equipped with current limiting fuses.



Industrial Plastic Fabricators, Inc. reports . . .

Lightweight Boltaron 6200 roof installations require far less structural support.

Complete Boltaron 6200 installation... ducts, tanks, hoods, blowers.



Boltaron[®] 6200

handles chemical & industrial fumes
at *Western Electric* *

*Western Electric, Merrimack Valley Works, North Andover, Mass.

Boltaron 6200

IS BEST BECAUSE:

- Protects against most corrosive fumes and liquids in any combination.
- Resists build-up of residual materials from corrosive fumes and liquids.
- Solid Boltaron has no coatings to peel or chip—does not require recoating or repainting.
- Chemically inert.
- Non-toxic, imparts no taste or odor.
- Can be welded, bolted, threaded, milled, ground, buffed and polished.
- Non-sparking—will not support combustion—handles fumes and liquids.
- High dielectric strength.
- Extremely lightweight—non-porous—and smooth surface.
- Tensile strength is 8000 psi.
- Can be joined by heat welding, solvent cementing, and threading.

IPF systems fabricated from Boltaron 6200 are being used across the country by many progressive manufacturers to solve a wide variety of industrial problems, especially where corrosive fumes and liquids have been extremely costly to handle. Performance proves Boltaron 6200 systems help decrease operating costs—increased operating efficiency.

For further information on performance-proven Boltaron 6200 systems, call or write:

Industrial Plastic Fabricators, Inc., Endicott Street, Norwood, Mass.



THE GENERAL TIRE & RUBBER COMPANY • Bolta Products Division • Lawrence, Mass.

WOLVERINE TUBE

Items of Interest to the Processing Industry

PUBLISHED BY WOLVERINE TUBE DIVISION

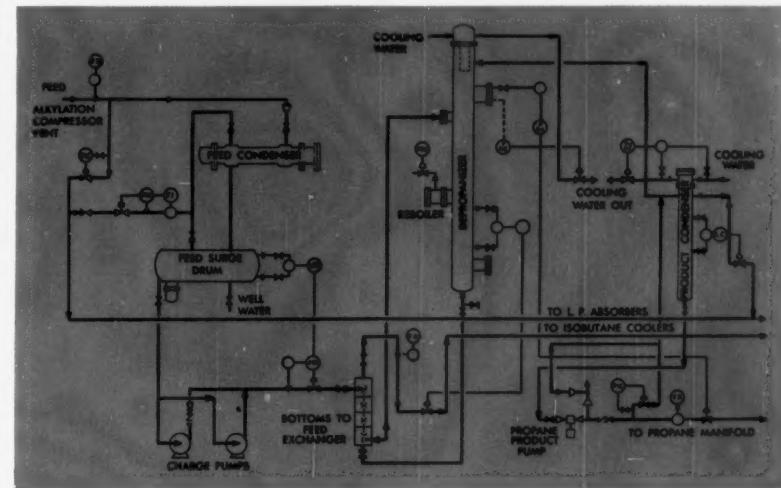
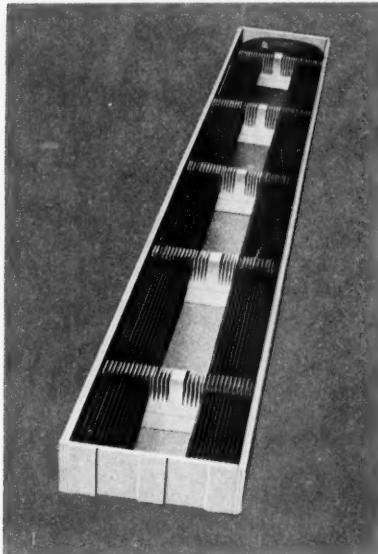
Wolverine Prefabs U-bends to your Specifications

As a direct mill source Wolverine Tube prefabricates U-bend condenser tubes to your specifications — ships them in disposable type pallets in the exact order of their installation — ready for direct insertion into your heat exchanger or condenser.

In addition to real savings in assembly time, you minimize transportation, space and handling problems.

In prime surface form Wolverine U-bends are available in a wide range of sizes and alloys in copper and aluminum. Capacity boosting Wolverine Trufin U-bends (such as those used in this application) are available in copper, copper alloys, aluminum and seamless steel. Wolverine Trufin tubes can be furnished in straight lengths or bent to your specification and packaged as shown here.

Write for complete information — or have your Wolverine sales representative explain their advantages. He is as near as your telephone.



Here's How:

WOLVERINE TRUFIN® CUT COSTS IN ALKY-SYSTEM DEPROPANIZER

BY ERNEST DODD

In refining—as in all industry—using the right product at the right time can often result in savings amounting to thousands of dollars.

A recent article in a trade publication gives dramatic evidence of the value of low-fin (Wolverine Trufin) condenser tubes in the design of the above low-cost alky-system depropanizer at a large Gulf Coast refinery.

From the article: "The advantage for the internal heat exchangers, low-fin U-tube bundles, lies in the investment savings in shells, floating heads and separate foundations."—"The advantage to this design in terms of the first cost is achieved principally by locating the reboiler and the overhead condenser inside the tower.

"This was achieved by the use of finned tubes to obtain high heat input per cubic foot of tower volume. It is estimated that the savings in terms of externally located heat-exchanger shells and foundations are about \$10,000. This saving is about 25 per cent of the cost of the tower itself, and 6 per cent of the total cost of the project."

The major components in the system

were: (a) a feed condenser using 70° well water makeup to the reservoir as coolant; (b) a 60-foot high by 30-inch diameter tower using Spraybak cartridge packing for liquid and vapor contacting; (c) an internal reboiler and reflux condenser; (d) an external product condenser doubling as a product accumulator, a bottoms-to-feed exchanger and one product pump.

It was in the area of item (c) that Wolverine Trufin proved its ability as a money saver. Internal mounting was advantageous in this instance because of Wolverine Trufin's greatly increased surface area. This enabled the engineers to get more heat transfer surface into a given area thus obtaining a higher heat input per cubic foot of tower volume.

Where Wolverine Trufin is installed savings and increased heat transfer performance go hand in hand. Throughout industry authenticated cases such as that described here are becoming daily happenings.

May we suggest that you include Trufin tube in your engineering philosophy when designing heat exchangers for your use?



PRIME SURFACE DUPLEX TUBING

WOLVERINE TRUFIN TYPE S/T-Duplex



WOLVERINE BIMETALLIC TUBE IS B-R*

* (BOND RESISTANCE RATED)

Designing new equipment using bimetallic or duplex type heat exchanger tube?

Then here's good news for you.

NOW — Wolverine Tube can tell you in advance exactly the amount of bond resistance between the inner and outer tubes of mechanically bonded tubing of dissimilar metals.

For example, production testing of Wolverine Trufin® Type L/C assures customers that this high-finned aluminum outer tube can be mechanically bonded to an inner liner of any desired metal and still maintain an assured and predetermined heat

transfer rate. Equally precise production testing of resistance values can be given on all other Wolverine finned and prime surface duplex tubing.

With this information determined in advance by Wolverine's newly developed bond resistance testing machine, it is now possible to obtain increased accuracy of design for heat exchangers and condensers using duplex tubing. This is of greatest importance where such tubing is used to combat corrosion.

Write — NOW — for complete information or ask for a Wolverine Technical Sales Representative to call.

Wolverine Trufin is available in Canada through
the Unifin Tube Division, London, Ontario.

CALUMET & HECLA, INC.
CALUMET DIVISION
URANIUM DIVISION
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Jet aircraft now get a new and wider safety margin when their fuels are dried with LINDE Molecular Sieves. Even at high fuel flow rates, water normally absorbed at ground level is reduced to less than 10 ppm—eliminating ice-blocked fuel lines at high altitudes.

Liquids never before dried successfully by desiccants can now be dried commercially with these new zeolite adsorbents. Examples are acetone and other ketones, ethanol and other alcohols, and most saturated and unsaturated hydrocarbons.

Drying to less than 1 ppm is now practical in dynamic systems. Due to their high water adsorbing capacity, LINDE Molecular Sieves bring pronounced savings in investment and operating costs.

No matter what the liquid—whether attempts to dry it have succeeded or failed—we would like to discuss with you what a Molecular Sieve design can do. Write Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N.Y. In Canada: Linde Company, Division of Union Carbide Canada Limited.

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AO PLASTIFAB GLOVES WITH

SOFT INTERLOCK LINING*

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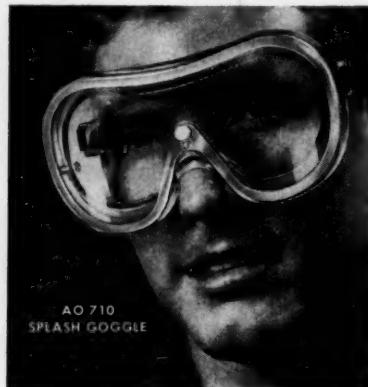
gloves and most coated gloves. Won't crack or peel. Combines the finger flexibility of a molded rubber glove with the added protection of a lining.

* The AO 300 series is the only complete line of interlock lined plastic gloves available.

Superb Splash Protection in the Only Goggle of Its Type on the Market

Developed in conjunction with a leading chemical company after many months of engineering and research, this goggle provides assured protection plus unusual comfort. Its indirect ventilation prevents build ups of high humidity and heat — and eliminates fogging. Light in weight, with wide angle vision for work efficiency, it fits over all types

of spectacles and safety R₃ glasses. A companion model (No. 711) protects from excessive and radiant heat and molten sodium splash. A forehead and nose shield gives added protection to these exposed areas. A hook on the nose shield permits use of a flame-resistant bib for protecting the lower face, if necessary.



AO 710
SPLASH GOOGLE

For Full Head, Face and Neck Protection Against Chemical Splash

Consists of vulcanized fiber headgear, rear drape and front bib of fire-resistant neoprene coated fiber glass, and clear acetate window. Quick fastening studs and end clips hold window secure. Snap fasteners hold neoprene

drape which encloses back of head and neck and hangs to shoulders. Bib attaches to lower edge of window and extends well down chest — splash can't enter under window when head is thrown back.



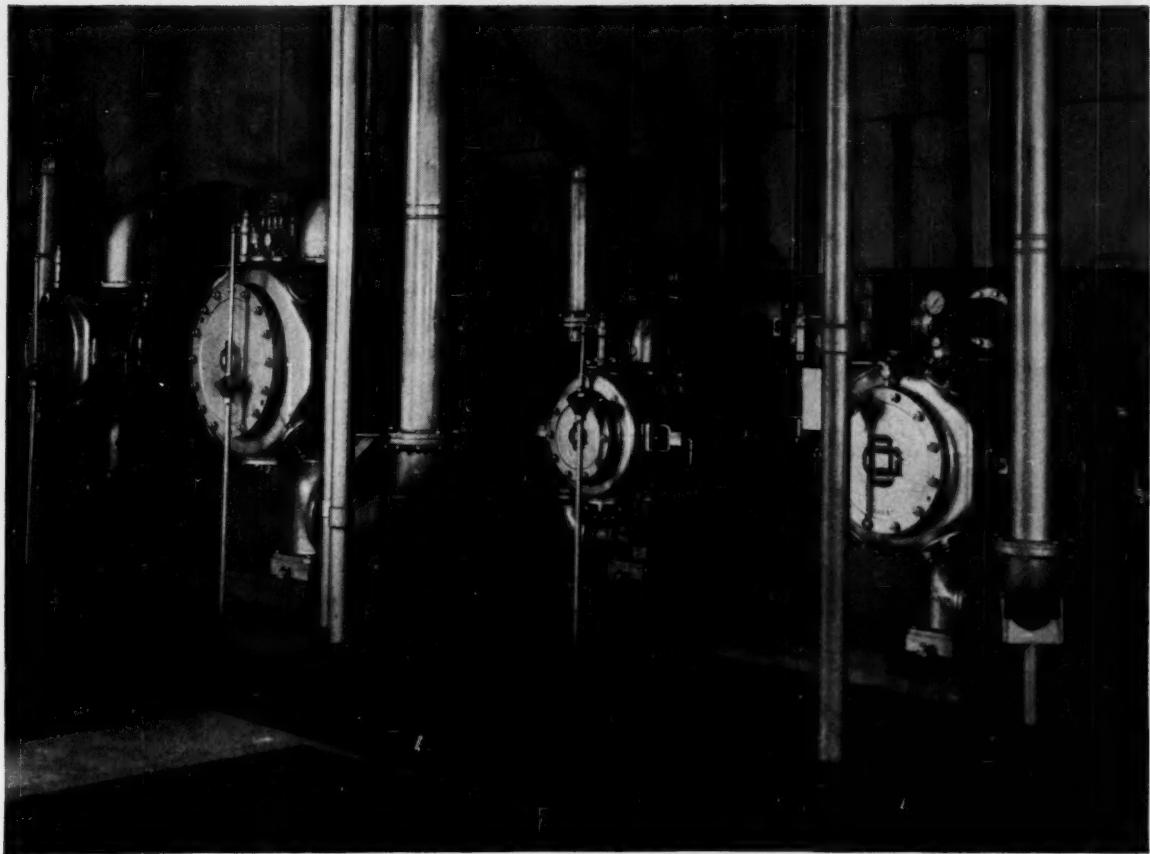
AO 157
CHEMICAL SHIELD

YOUR NEAREST AO SAFETY PRODUCTS REPRESENTATIVE CAN SUPPLY YOU



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Always insist on AO Trademarked Safety Products



New Gardner-Denver HAF compressor (left) now supplies all air for a large plant. HAC (right) was retained as a stand-by unit.

How to modernize your plant with a planned compressed air system



IN INDUSTRY—SPEEDING THE PACE,

the Gardner-Denver specialist is an integral part of the team. He works side by side with engineers and designers, helping to solve their problems, for at Gardner-Denver there's no substitute for men—our 100-year philosophy of growth.

In a sweeping modernization of its compressed air system, a large Midwest foundry recently replaced several small, power-eating compressors with *one* large Gardner-Denver HAF. The new unit is 23 & 13½ x 14, delivering 1750 cfm. Now the plant has a *planned* compressed air system—resulting in considerable power saving, and efficient air flow throughout the plant.

Even though the new HAF supplies all the air for normal plant operations, a Gardner-Denver HAC with a capacity of 750 cfm was retained as a stand-by unit. Other steps in the modernization included installing a new air receiver and a new, larger 8" air line.

It'll pay you to take a close look at *your* compressed air. You may find modernization with a planned system a big cost-saver. A Gardner-Denver compressed air specialist will gladly look at your entire system—your compressor installation, your distribution system, your air uses and your maintenance of air tools. He can recommend the best solution to any compressed air problems you may have.

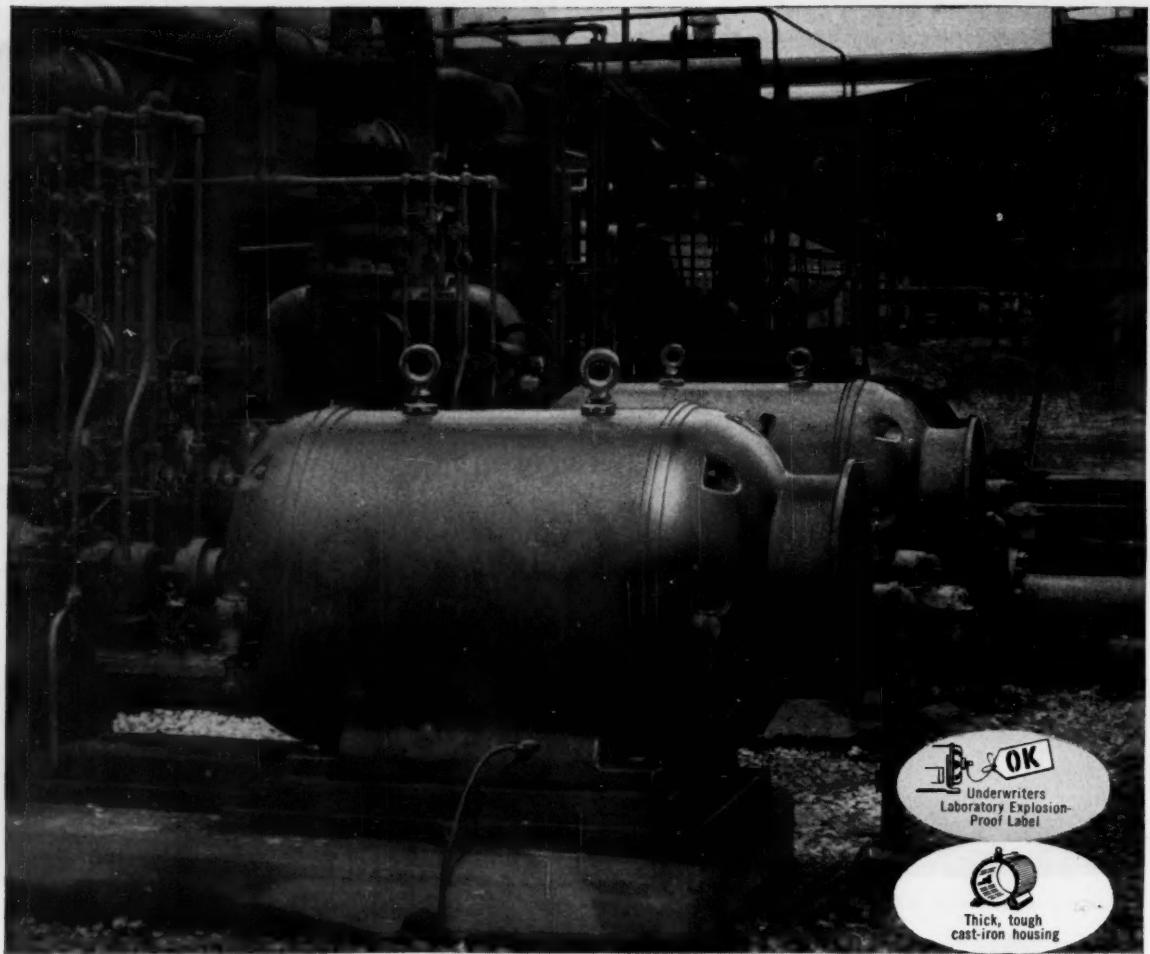


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Gardner-Denver Company, Quincy, Illinois

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New improvements in Louis Allis explosion-proof motors meet latest demands of abusive chemical service

You need tough-shelled, explosion-proof motors in the corrosive, volatile atmospheres of many of today's modern chemical processing plants.

For this rugged use, Louis Allis, the *originator* of the fan-cooled explosion-proof motor, has continued to develop new designs of direct benefit to the chemical industry: Cast-iron housings with extra-high corrosion-resistance—special varnishes that provide maximum insulation against moisture, acids, and alkali—more effective cooling with aerodynamically designed non-sparking fan.

Now, to match increasing industry demands, Louis Allis offers explosion-proof motors in the *large* sizes — up to 600 horsepower.

What's more, these motors are available in a wide range of mechanical modifications and electrical characteristics to meet many of your requirements. See the complete story in our Bulletin 800, "Explosion-Proof Motors." Contact your Louis Allis District Office, or write today to the Louis Allis Company, 447 East Stewart Street, Milwaukee 1, Wisconsin.

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CONTENTS

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It may take an explosion, or a truck running rampant, to throw an RMC thermometer out of calibration . . . but it does happen sometimes. When it does, you want to get it back on the job in a hurry.

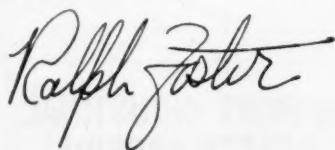
That's why our engineers included an *external* dial reset screw on the back of the RMC industrial thermometer—so that it can be reset instantly without shutting down or closing off a line.

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If you have any temperature, pressure, or liquid level measuring problems, write, wire or phone. The chances are we have the indicating instrument you want. If we don't, we'll build it for you, or tell you where you can get it.

A handwritten signature in cursive ink, reading "Ralph Foster". The signature is fluid and personal, written over two lines.

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News from National Carbon Company

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National Carbon
representatives expand
your engineering force



T. W. MANCHESTER — SALES ENGINEER

Mr. Manchester was graduated from Pennsylvania State University with a B. S. Degree in Chemical Engineering. For nine years he worked as a Product and Process Control Engineer at National Carbon's Clarksburg and Columbia Plants. Here he was involved with production control for the manufacture of electrodes, anodes and specialty grades of graphite.

After joining the Chemical Products Sales Group, Manchester worked for a period in the design group. Since 1958, he has been a field engineer covering the Southeastern Sales District.

Carbon and Graphite unmatched as materials for high-temperature applications

In recent technical articles covering materials of construction for high-temperature chemical processes, reference is made to graphite as the best available material for applications in neutral or reducing atmospheres. At temperatures up to 4000°F., graphite exhibits excellent structural properties such as: no deformation, relatively high strength, immunity to thermal shock and, most important of all, is its complete chemical inertness.

For twenty years, NATIONAL CARBON Engineers have been engaged in designing graphite equipment for use in high-temperature chemical processes. This work

has covered both operational and mechanical features of the equipment. Some of the outstanding results of these efforts are: graphite water-cooled combustion chambers for burning elemental phosphorous, carbon or graphite towers for hydrating phosphorous pentoxide to phosphoric acid, graphite linings for high-temperature chlorination of boron, zirconium and columbium, graphite resistance furnaces for heating corrosive gases such as chlorine up to 2500°F., and graphite high-temperature vacuum reaction furnaces for the reduction of ores to the metals.

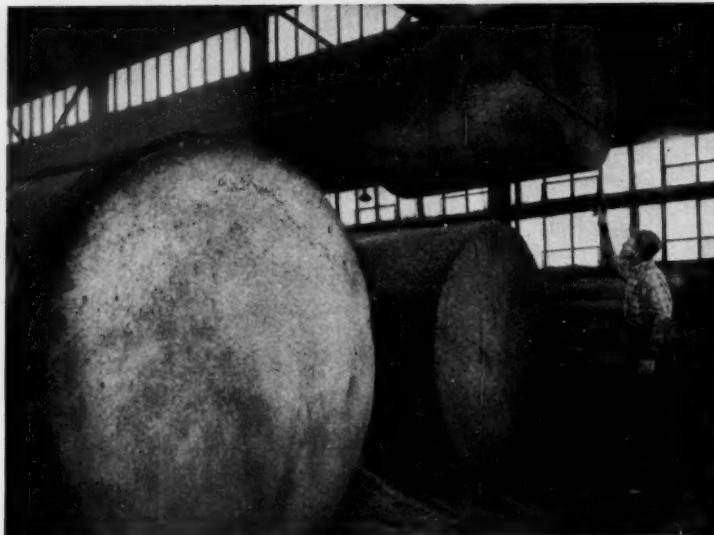
NATIONAL CARBON Engineers have gained extensive experience in the development of equipment for these high-temperature chemical applications. This experience can prove helpful in the design of equipment for new applications. If you wish to consult a NATIONAL CARBON Engineer, write National Carbon Company, P. O. Box 6087, Cleveland 1, Ohio.



"National", "Karbate", "N" and Shield Device and "Union Carbide" are registered trade-marks of Union Carbide Corporation.



LARGE DIAMETER GRAPHITE STOCK FILLS NEED OF CHEMICAL PROCESS INDUSTRY



Unloading 61" diameter x 72" long graphite from graphitizing furnace

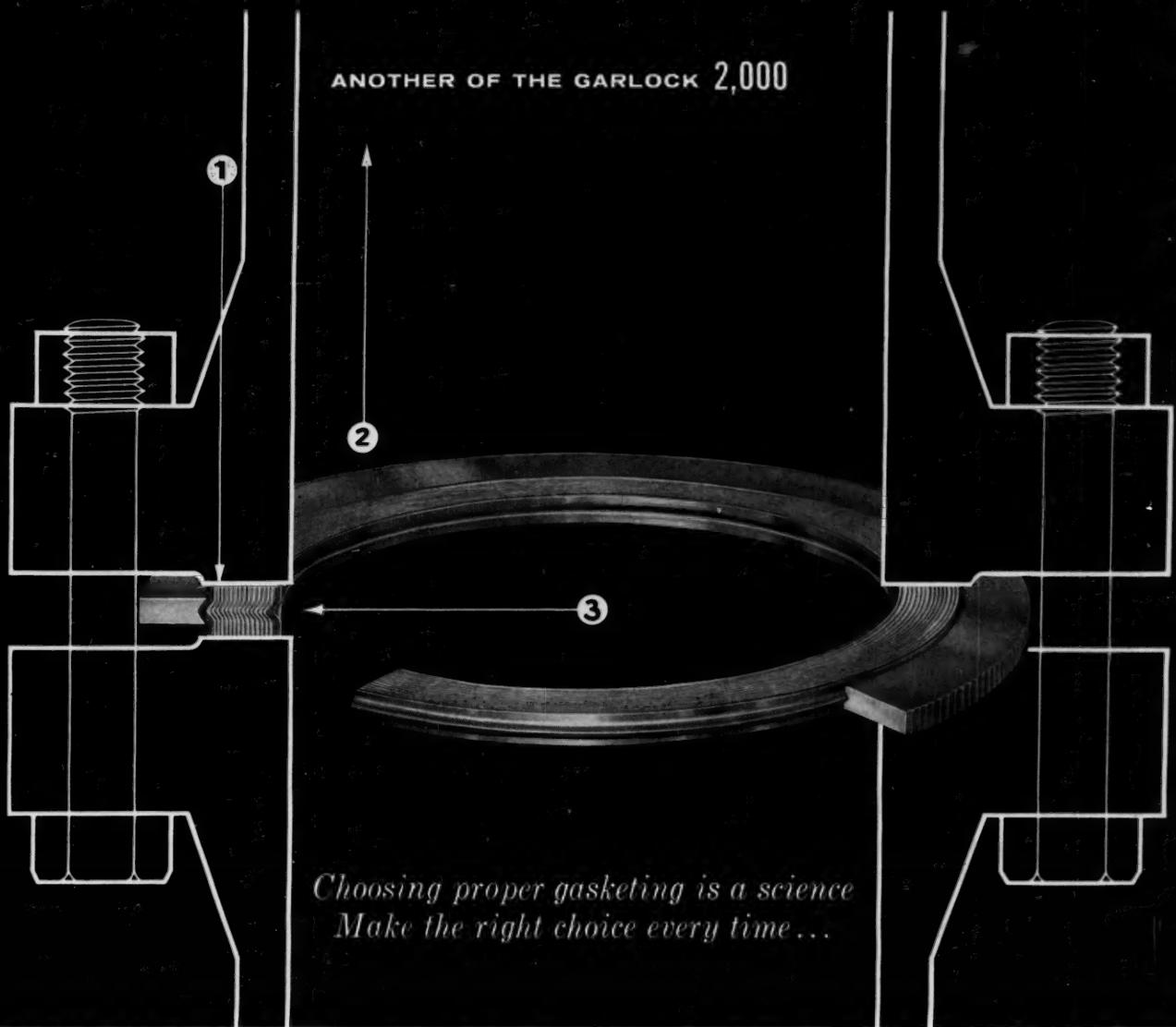
National Carbon Company has completed production of the largest diameter fine-grained graphite specialty stock ever produced. These pieces are 61" in diameter, 72" long and weigh approximately 7 tons each.

The production of this large size graphite allows fabrication of essentially monolithic high temperature process equipment. Monolithic construction lends itself to easier field erection and lower maintenance because it minimizes the number of joints required.

Five of these pieces are to be machined into sections for a graphite tower. The tower will be used for production of phosphoric acid from the burning of elemental phosphorous.

This is another example of National Carbon's continuing research, development and production efforts to meet the growing demands of the chemical processing, nuclear, and aircraft industries for large size graphite stock.

ANOTHER OF THE GARLOCK 2,000



*Choosing proper gasketing is a science
Make the right choice every time...*

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Expertly-engineered GUARDIAN gaskets provide the necessary resilience and flow required by:

1. **BOLT LOAD** . . . seating force needed to make the gasket flow into the flange face imperfections to maintain tight seal against internal pressure
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Garlock GUARDIAN Gaskets are constructed of spiral-wound strips of V-shaped metal alternated with layers of asbestos paper or TEFLONT. By increasing or decreasing the number of layers the compressibility of GUARDIAN gaskets can be changed to meet different pressure and bolt loads—in no other type gasket can this be done!

Where operating conditions are unusually severe, apply TEFLONL Garlock GUARDIAN gaskets to assure safe, positive

*Registered Trademark

†DuPont Trademark for TFE Fluorocarbon Resin

Canadian Division: The Garlock Packing Company of Canada Limited
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sealing against practically all chemicals at temperatures from -300°F. to +450°F. For service against oils, steam, gases, liquids, at temperatures as high as 1050°F., pressures to 2500 psi, use asbestos-filled GUARDIAN Gaskets.

GUARDIAN gaskets are another of the Garlock 2,000 . . . two thousand different styles of packings, gaskets, and seals for every need. The only complete line. Ask your local Garlock representative for his unbiased recommendations. Or, write for Folder AD-104.

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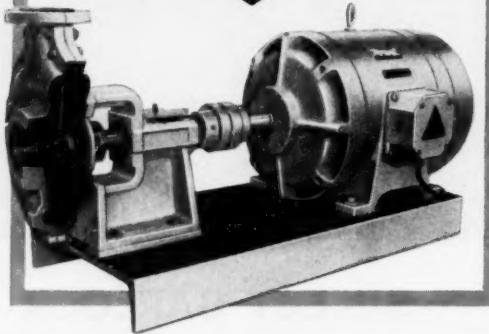
INDUSTRIAL operates one of the largest rubber compounding and lining plants outside of the rubber industry. Here, tons of raw rubber are maintained in stock for formulating and compounding into compression molds and rubber linings to meet the *most specific* corrosion or abrasion-resistant services.

This extensive facility permits INDUSTRIAL to maintain the highest standards of quality control for rubber-lined processing equipment designed and built by INDUSTRIAL. In addition, it also provides a skilled, experienced and well-equipped source for *custom* sheet lining and compression molding to meet individual requirements.

All the benefits of INDUSTRIAL'S experience in designing, engineering and producing rubber components, and for applying it to the most intricate surfaces, is described in our RUBBER DIVISION bulletin. Write for your copy, today.

BIG JOB. 35 ft. long rubber-lined tank truck assembly is prepared for vulcanizing in INDUSTRIAL's 40-ft. long vulcanizer.

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INDUSTRIAL Centrifugal Pumps are specifically designed for rubber lining. As a result, they characteristically provide long, trouble-free life in corrosive or abrasive service . . . offering these design benefits:

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- One-piece, maintenance-free rotating element

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NEW CATALOG

... ON ANACONDA FLEXIBLE CONNECTORS OF TEFLON*



Hose assemblies of Teflon, like those illustrated above, were designed to help meet tough problems—temperature extremes, corrosion, high pressure in conveying chemicals, searching liquids, fuel, oils, oxygen, steam—or in hydraulic and conduit applications. A standard assembly may handle your job, help you cut costs. If not, our laboratory and test facilities, as well as engineering services, are available to help in design and development of hose assemblies for special applications. Let us show you how we can help you handle tough problems with Anaconda Flexible Connectors of Teflon. Send for catalog today.

^aTeflon is a DuPont trademark for TFE—fluorocarbon resin.

WHEREVER CONNECTORS MUST MOVE

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An easy-to-use
16-page book
with complete data,
drawings, photos



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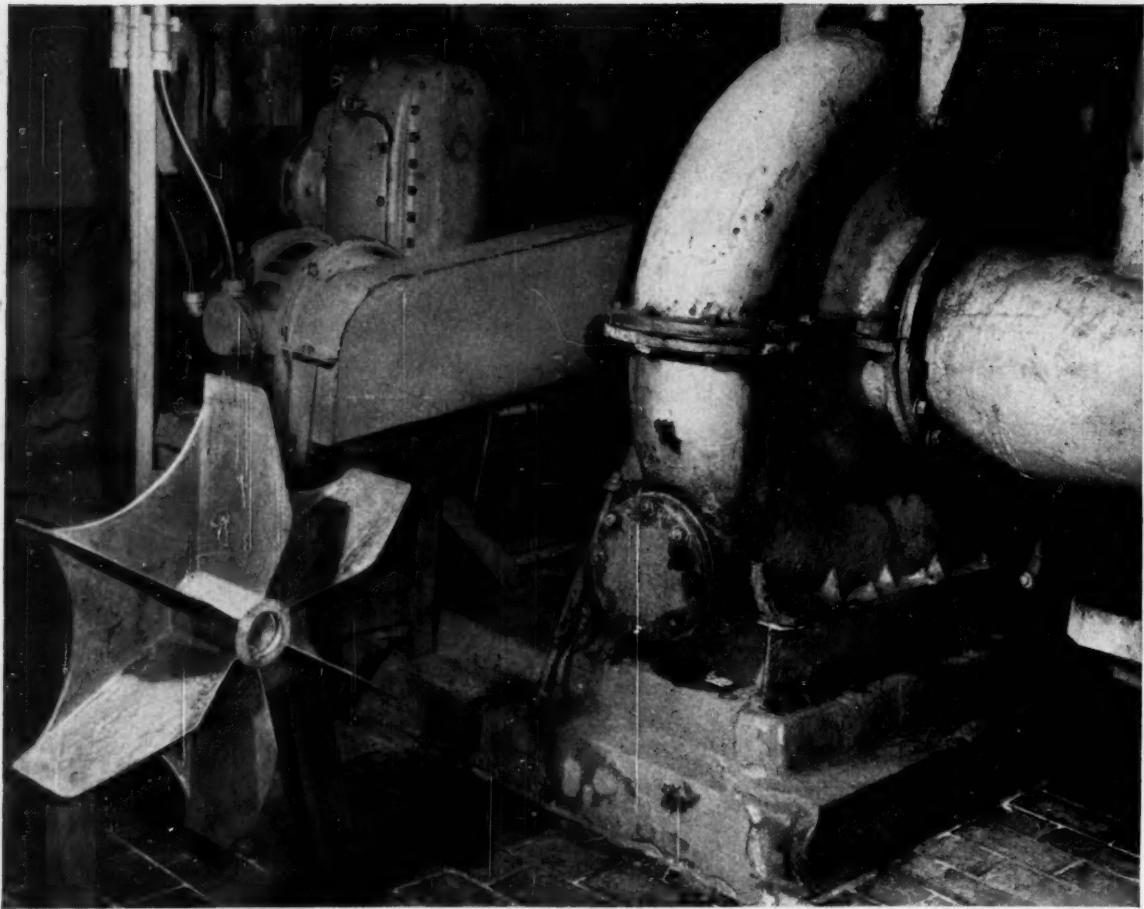
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The impeller you see has been a spare for 10 years!
Both it and the working impeller inside the housing at right are Illium "G", a 56% nickel alloy par-

ticularly resistant to the SO_2 gases handled by the blower. The blower is installed at the Crown-Zellerbach Corporation plant in Camas, Washington.

Spare nickel alloy impeller for SO_2 sits unused for 10 years!

... working impeller's still good for years to come

SO_2 gases are mighty hard on most impeller metals. Yet, the spare impeller you see has not been needed since the blower went in over 10 years ago! Blower exhausts 17% SO_2 gases at 90°F from pulp mill sulfur burners.

Both impellers are Illium "G"*, a high-nickel alloy cast by Stainless Foundry and Engineering, Inc., Milwaukee, Wisconsin. This high-nickel alloy provides superior resistance to the corrosive attack of many strong acids (particularly sulfur compounds), caustics, oxidizing and reducing agents, and sea

water. It's readily welded and machined, too.

You'll do well to check the advantages of high-nickel alloys when designing for severe environments. Whether you're handling halogens, acidic or caustic corrosives, temperamental foodstuffs . . . whether temperatures are high or low, you'll find a nickel alloy to give you long, economical service.

*Registered trademark, Stainless Foundry & Engineering, Inc.

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NICKEL MAKES ALLOYS PERFORM BETTER LONGER

ALL-NEW ALEMITE "77" LUBRICANT PUMP packs most power

FOR HIGHEST PERFORMANCE!

68% More Powerful . . . outperforms any other air-operated lubricant pump of its class on the market today! The all-new 5.2 horsepower Alemite "77" Pump assures smoothest, fastest delivery of all lubricants, through longest lines!

Three Master Pressure Ratios for unequalled delivery of all lubricants—fluid, semi-solid and heavy fibrous types. Lightweight, rust-proof aluminum construction.

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All-New Alemite "77" Features!

- **Volume Air Distributing Valve**—self-seating, self-cleaning, volume porting
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- **Straight-Line Exhaust** has extra-large port for highest pump efficiency
- **Hardened Steel Piston and Cylinder**, lapped to a precision fit of 125 millionths of an inch
- **All-Steel Primer Valve**, ground to a perfect seal . . . hardened for abrasion resistance
- **Dynamic Primer** assures priming and pumping of heaviest lubricants.



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**THREE POWERFUL
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- **Medium-pressure** (25 to 1 ratio) for heavyweight oils and light-bodied greases. Delivery on both up and down strokes.

- **Volume delivery** (6 to 1 ratio) for light-bodied fluid lubricants. Single-acting pump mechanism.



Write for New Alemite
"77" Pump Catalog!

PRACTICE . . .

PROCESS FLOWSHEET C. S. CRONAN

Natural Gas Processing Plant

Extensive gas reserves are tapped for chemicals and fuel.

Field gases go through processing on way to fuel-market.

New operation recovers sulfur and hydrocarbons from wet, sour gas.

Plant is designed for easy doubling of throughput.

IN THE Alberta foothills of the Canadian Rockies, 20 mi. from the U. S. border, British American Oil Co., Ltd., has completed its Pincher Creek plant for processing natural gas from nearby wells. Pincher Creek—named for a rusty pair of miner's pinchers found in a creek bed there in the '70's—is in the center of one of the largest of the fabulous Alberta gas fields.

As is true of much of the estimated 300 trillion cu. ft. of gas reserves in western Canada, the H₂S content is very high—almost 11% in Pincher Creek, equivalent to about 3.5 long tons recoverable sulfur/MMcf. gas. B-A processes gas (on its way to eastern markets via the 2,300-mi. Trans-Canada Pipe Line) to recover condensate (natural gasoline), sulfur and LPG (propane and butane).

Based on a throughput of 142 MMcf. gas/day, the plant can recover daily 100 MMcf. residue gas for sales or reservoir pressure-maintenance, 4,200 bbl. stabilized condensate, 20,000 gal. propane, 30,000 gal. butane and 500 long tons sulfur.

Because the plant is located in the midst of ranches and farms, special attention was paid to air and surface pollution in plant design and installation. Residual sulfide gases from the

sulfur plant are burned to SO₂ and discharged to the air through a 350-ft. stack. Other plant waste gases are flared through another stack, where a pilot light burns H₂S to SO₂.

Pincher Creek has conventional service facilities. Steam is generated at 300 psig. in three boilers with 100,000 lb./hr. capacity each. Power is purchased from two separate sources to reduce risk of power failure. Process cooling comes from an induced-draft cooling tower, with makeup water from a small lake created by a dam across the Drywood River a mile away.

Diversified products give B-A an interesting group of customers. LPG is sold as industrial and domestic fuel; condensate serves as part of the feedstock for B-A gasoline; sulfur customers include fertilizer, pulp and paper, and mining operations; dry residue gas goes to pipeline consumers in east Canada.

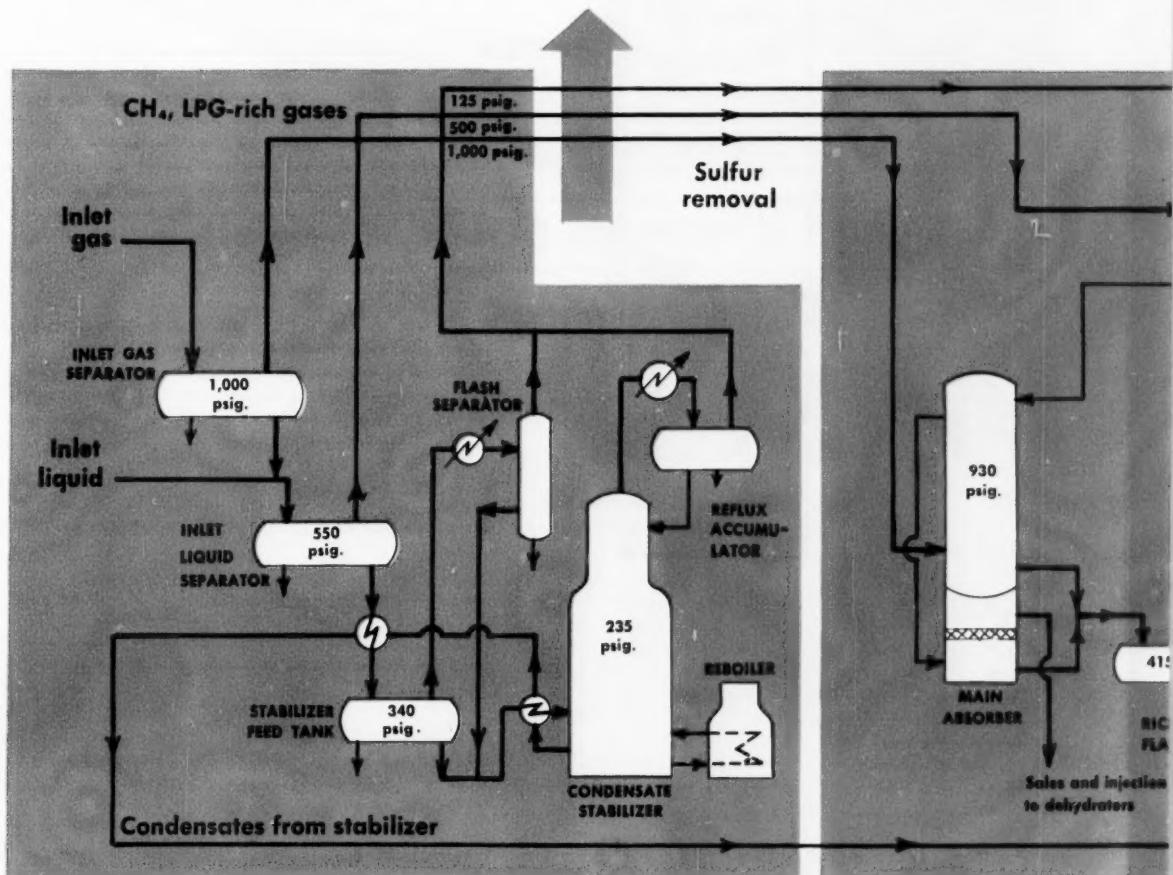
An important significance of Pincher Creek to B-A (a 58%-owned affiliate of Gulf Oil Corp.) is that it opens vast natural gas reserves to exploitation in chemical and petrochemical ventures. Looking to the future, B-A designed the plant so that its capacity can be upped to 240 MMcf. daily by stage additions.

Unfold Flowsheet



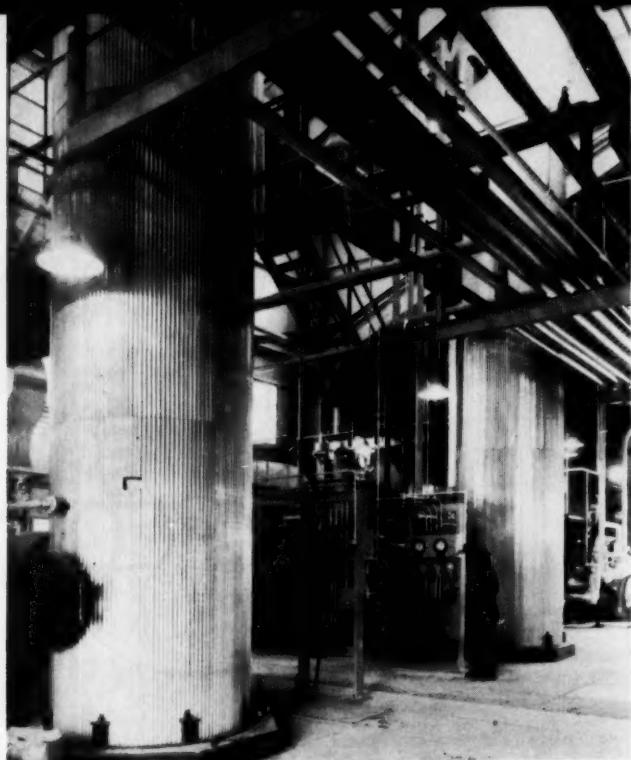
Monoethanolamine Plant Recovers H₂S From Stream

After separation from gases pass to one of these (depending on stream where H₂S and CO₂ are removed). Aqueous monoethanolamine stream is heated, a stripped out a feed to the sulfur plant. CO₂ requires inside operation process units at Pincher Creek.



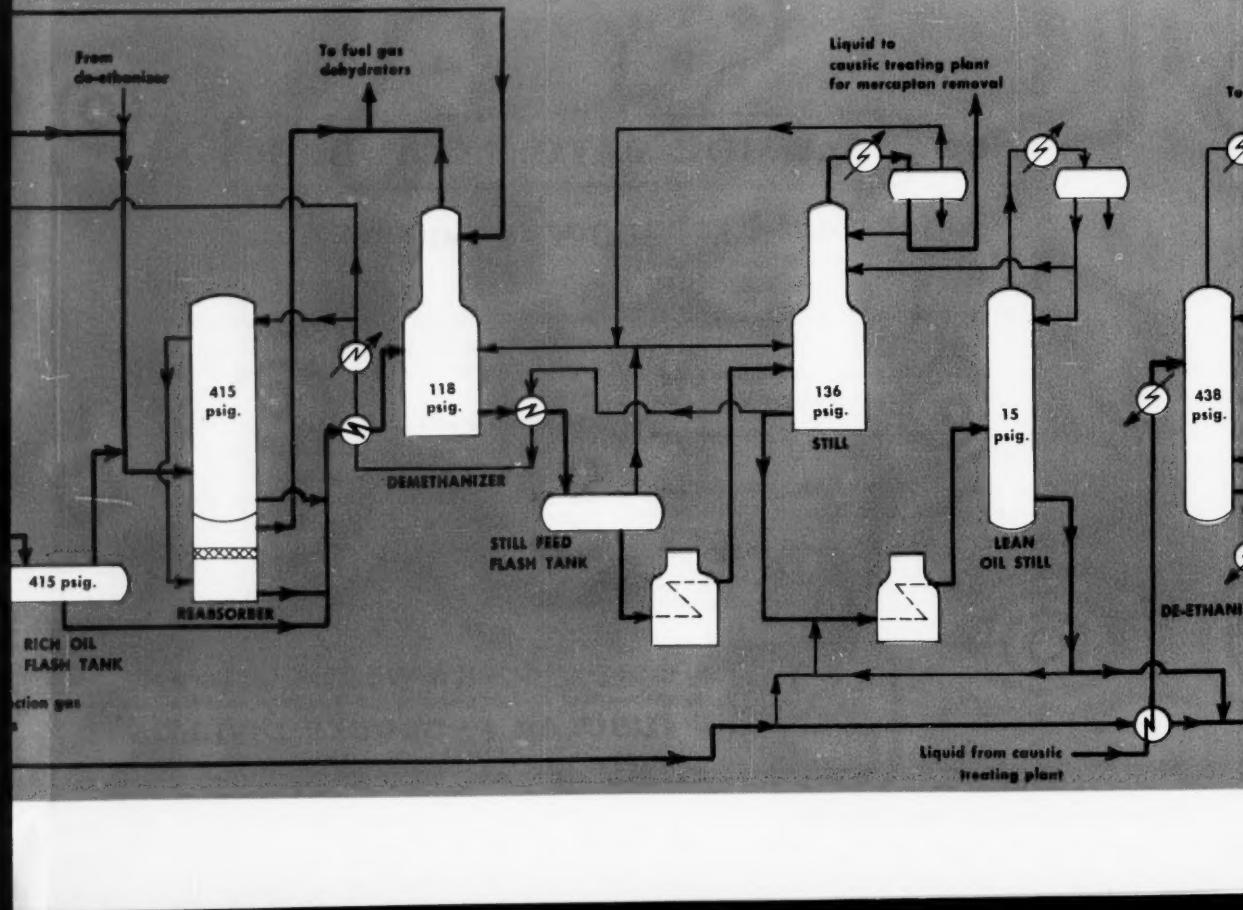
Plant Stream

from liquids, all these contactors (at steam pressure) are removed with lean amine. Rich acid is sent, and the acid sent as a cut. Cold weather conditions for most of the year.



Oxidation Converter

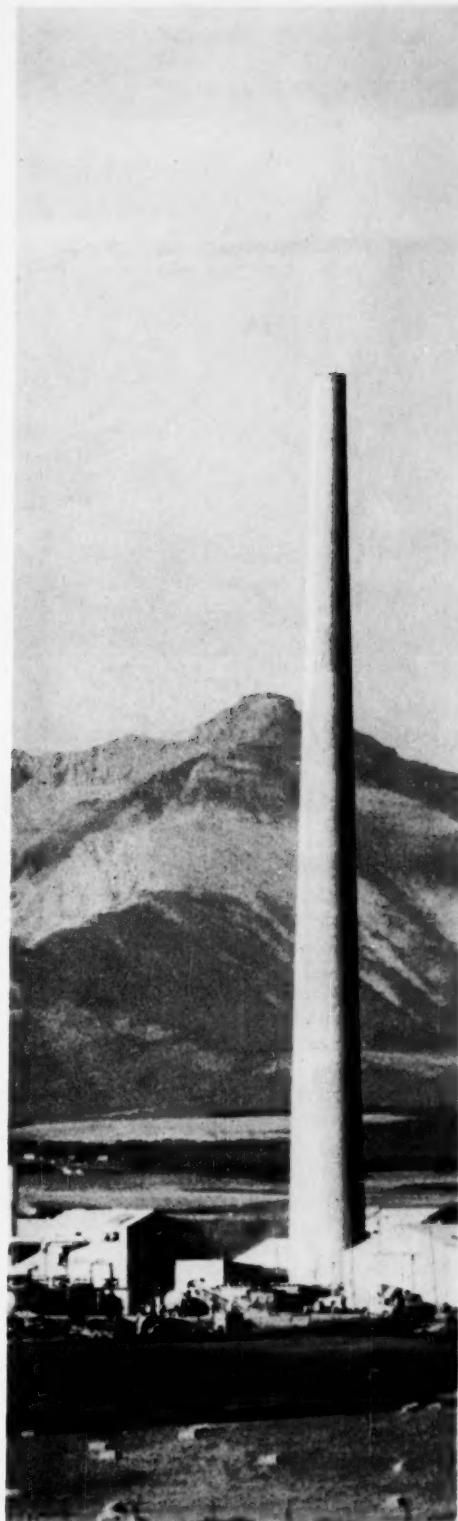
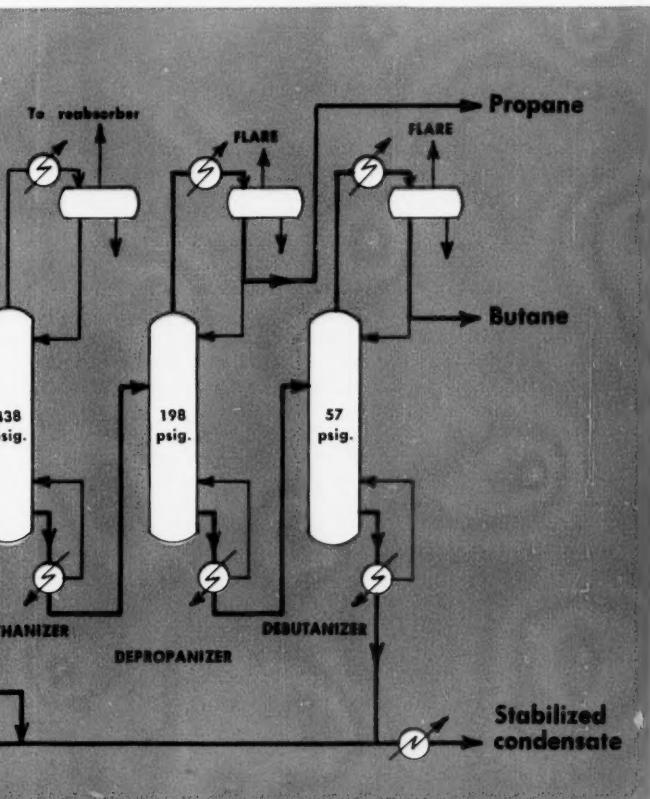
Elemental sulfur is reacting one-stage with H₂S in the presence of catalyst. The furnace passes where liquid is heated by steam from the coker.



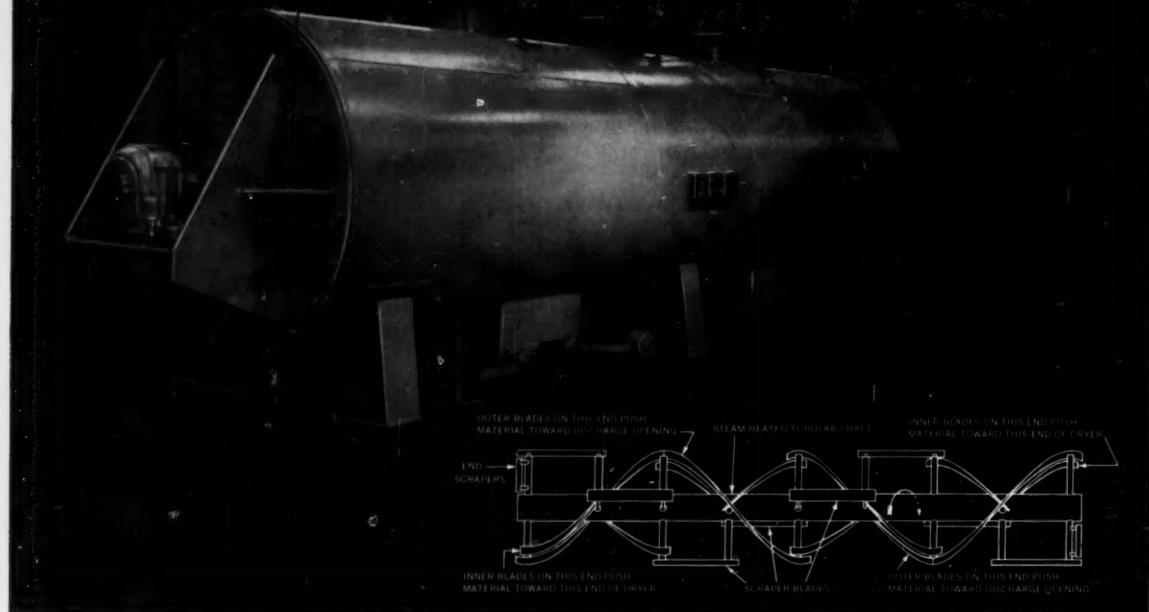
Oxidation process converts H₂S to Sulfur

Elemental sulfur is made by burning one-third of the H₂S to SO₂, and reacting SO₂ with the rest of the H₂S in the presence of bauxite catalyst. Hot gas from the reactor furnace passes through these condensers where liquid sulfur is recovered. Process heat is removed by producing steam from cooling water in the shell of the condensers.

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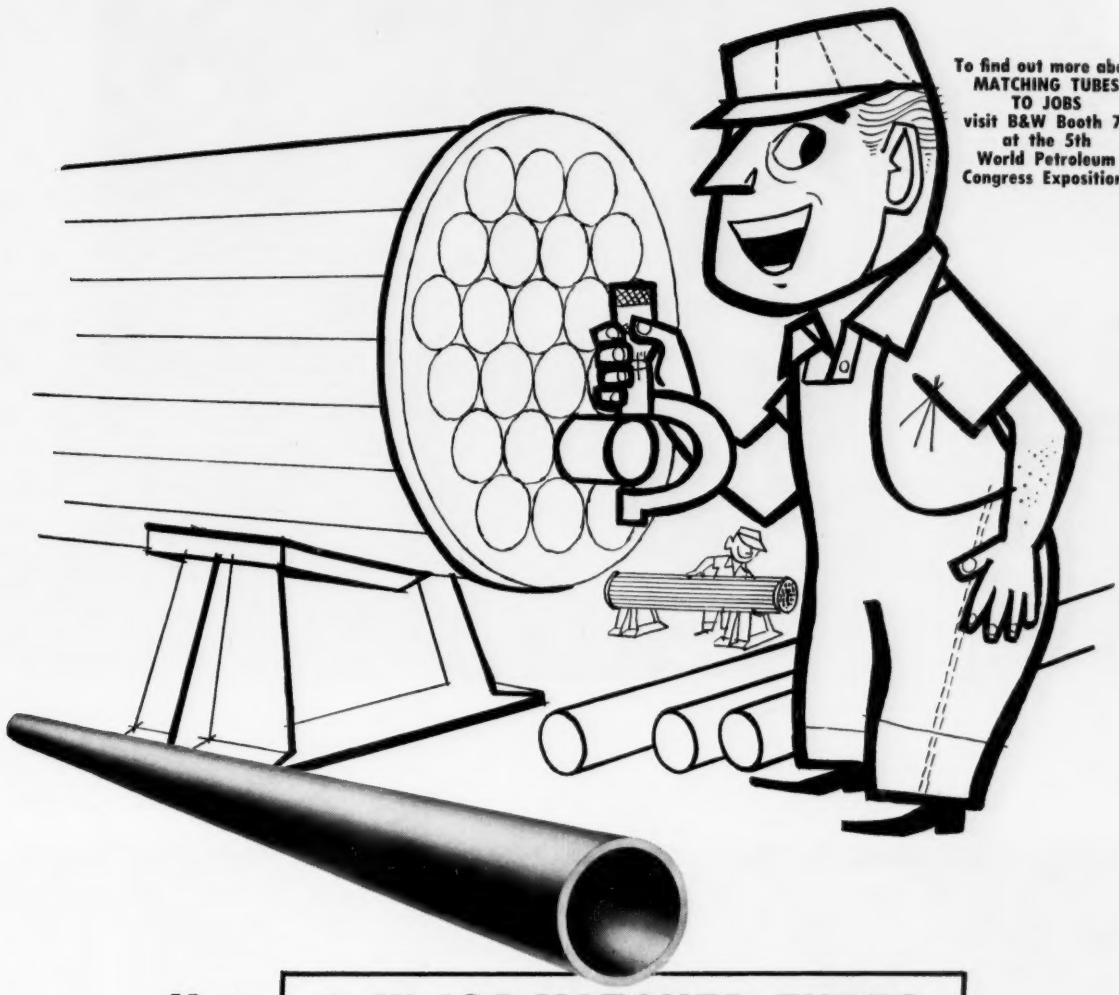
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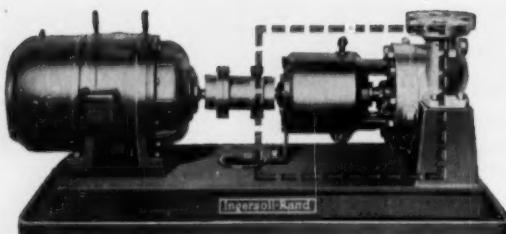


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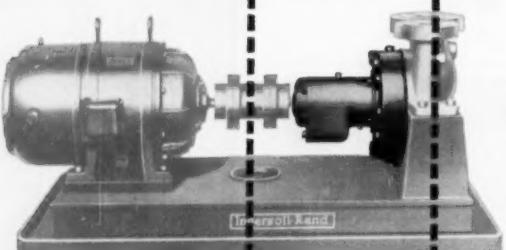
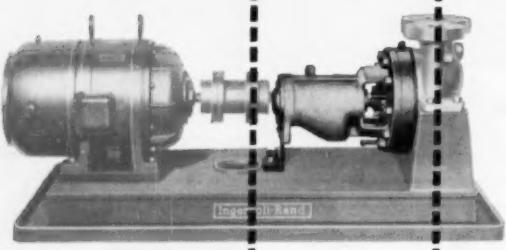
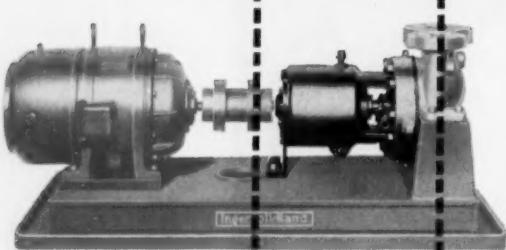


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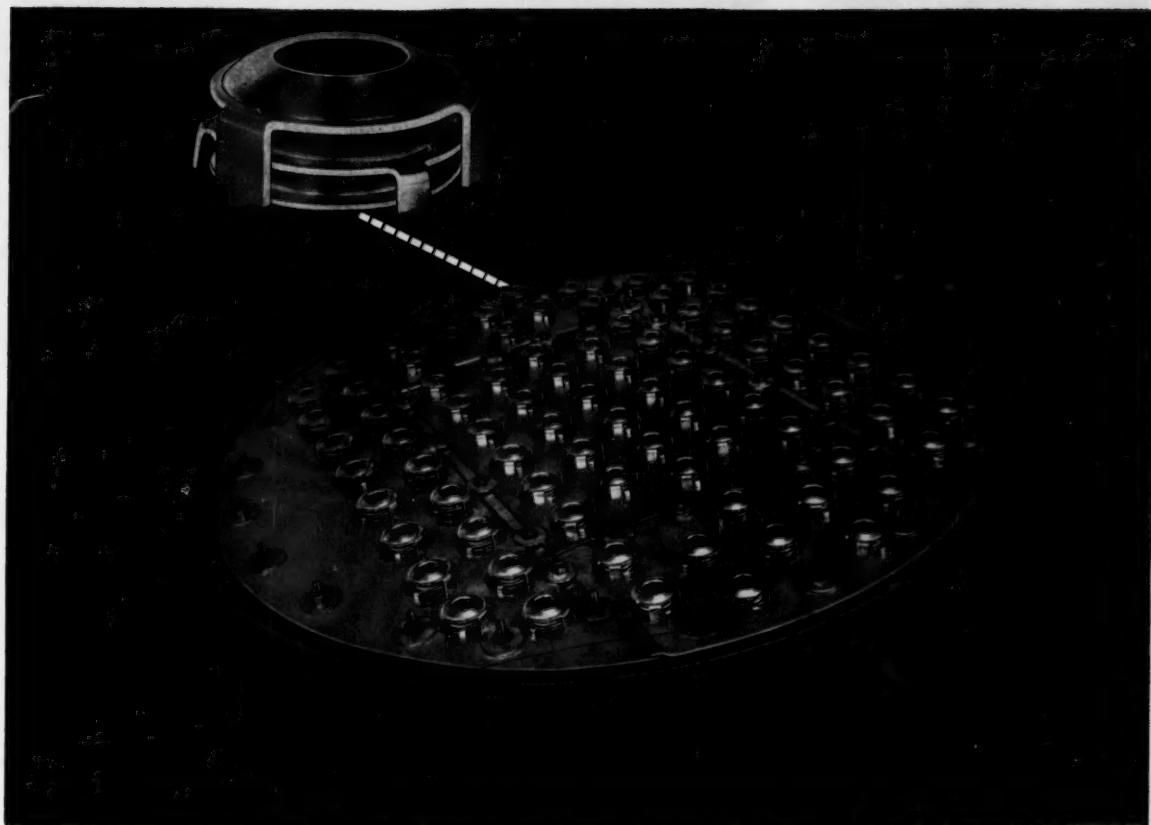
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CHEMICAL ENGINEERING—April 20, 1959

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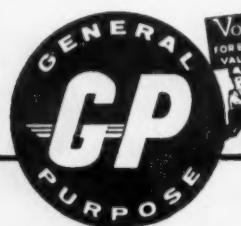
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APRIL 20, 1959

SAFE HANDLING OF “Reactive” Chemicals

A. B. STEELE and J. J. DUGGAN
Union Carbide Chemicals Co.

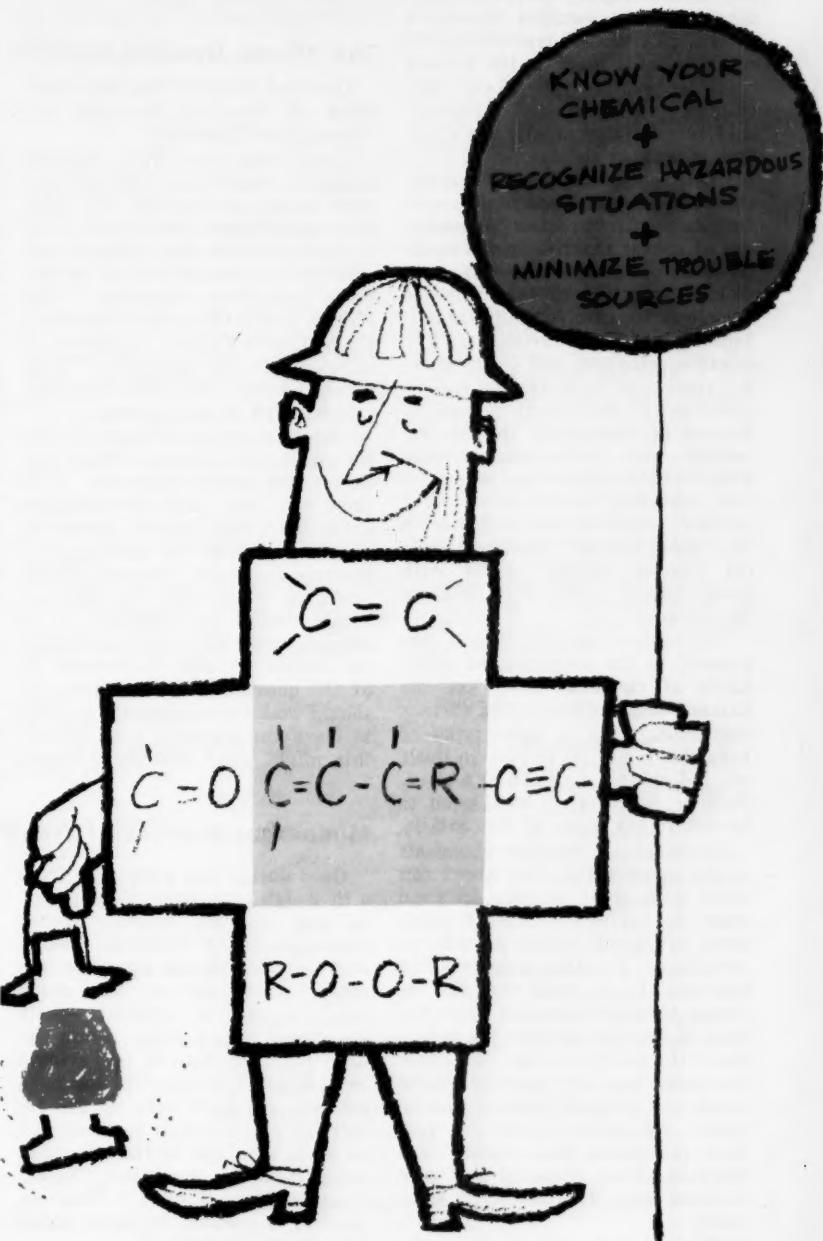
ENGINEERS in most parts of the chemical industry are concerned with reactive chemicals. They may be operating plants, developing processes, or designing plants. It is our purpose in this article to review our company's experiences in handling of reactive chemicals and to pass these ideas along to other chemical engineers so that they can achieve greater safety in handling such materials.

To start off, what do we mean by a “reactive” chemical? Obviously, not all chemicals that can react. A “reactive” chemical is defined here as a material which will vigorously polymerize, decompose, condense, or otherwise react with itself in the pure state—or in the presence of a catalytic amount of some other material—or which will react violently with water. (See Table I.)

Reactive chemicals are unusual in that they can react violently under conditions which might not appear hazardous to the average person.

Examples of materials which react with themselves in the pure state when subjected to shock or

This Report embodies the combined thinking of many individuals and departments within Union Carbide Chemicals Co. It is the result of work by a Reactive Chemicals Project Committee composed of Mr. Duggan, as chairman, and Dr. Steele, as a member, together with representatives from the seven manufacturing plants and the Research, Medical, Development and Engineering departments of the company. The authors wish to acknowledge especially the contribution of Robert W. King, of the Engineering Department, who was the original chairman of the committee.—Editor.



A CHEMICAL ENGINEERING REPORT

heat are acetylene and ethylene oxide. Acrolein is an example of a chemical which reacts vigorously with itself when contaminated with a catalytic amount of some other material. Other examples of this type of reactivity include acetaldehyde, acrylonitrile and hydrogen cyanide.

The various unsaturated vinyl monomers such as vinyl chloride, ethyl acrylate and butadiene are polymerized rapidly and sometimes dangerously by catalyst traces.

Examples of the materials which react violently with water include acetic anhydride, phosphorus oxychloride, concentrated sulfuric acid, concentrated caustic and alkali metals such as sodium.

Other chemicals which are excluded from consideration by our definition of a "reactive" chemical are of course reactive in the usual sense of the word. Vigorous, even violent, reactions of two different chemicals are involved in the manufacture of many products. For example, ethylene and chlorine react vigorously to form ethylene dichloride. If the reaction were to get out of hand, or if the two reactants were to be inadvertently mixed outside of the reactor, a serious explosion could occur. But neither ethylene nor chlorine is considered here as a reactive chemical because neither reacts with itself, except under very unusual conditions.

Still other hazards which are present in the operation of many kinds of chemical plant are the flammability and toxicity of various chemicals. Each of these types of hazard is a subject worthy in itself of individual consideration. Neither, however, is considered to be within the scope of this article.

Reactions of reactive chemicals in the manner described above can occur with great violence, in some cases so explosively that rupture disks or safety valves provide no protection. In other reactions the rate may be so rapid that the increase in vapor pressure from the heat of reaction exceeds the capacity of the relief devices. Still other reactions may not rupture equipment, but internal damage may be great. No general rules are possible concerning the violence of a reaction. Each chemical and each reaction must be considered separately.

Predicting the extent of reactivity

from chemical structure is uncertain, although certain types of structure (See Table I) do provide an indication. Each case should be studied separately and in detail to determine the hazards involved.

Nor are thermodynamic properties a reliable measure of reactivity. For example, the heat of formation and the free energy of formation of benzene would indicate that the material should decompose to its

elements as does acetylene. Yet, benzene is one of the most stable of hydrocarbons.

Similarly, the action of polymerization catalysts and inhibitors is poorly understood. An excellent inhibitor for one monomer may be very poor for another monomer closely related in structure. In all of these matters, judgment, experience and laboratory tests are the only true guides for evaluation.

The "Three Commandments" of Safe Handling

The first rule for the safe handling of reactive chemicals is: "Know Your Chemical."

Those who deal with reactive chemicals, beginning with the laboratory and ending with the shipping department, should first of all be familiar with the physical and chemical properties of all potentially hazardous materials. The Physical and Chemical Properties Check List in Table II is offered as an answer to the question: "What should I know about reactive chemicals handled in my process?"

The first group of items in the Physical and Chemical Properties Check List applies generally to all chemicals—not just to reactive chemicals. The second group of questions applies in particular to reactive chemicals. Anyone having anything to do with the development, design or operation of a process involving a reactive chemical should be able to answer all of the questions. If he cannot, he should make arrangements at once to learn the answers, even though this might need laboratory study.

The second rule for the safe handling of reactive chemicals is: "Know How Hazardous Situations Can Occur," or "Recognize Hazardous Situations."

Only if hazardous situations are anticipated can corrective measures be taken before an emergency occurs. Each person involved with reactive chemicals should go over the Potential Sources of Trouble Check List (given in Table III) with his own process, flow diagrams, or processing unit in mind.

The third rule for the safe handling of reactive chemicals is to take steps to "Minimize Trouble Sources."

All of the various sources of trouble noted in Table III can probably never be completely eliminated. The design engineer and the operating unit supervisor can reduce their number to a minimum, however, by means of good design and intelligent operation. This involves knowing the limitations of both the equipment and the material in process and thus defining the limits of safe operation.

Minimizing Sources of Trouble by Design

Good design can grow only from a thorough knowledge of the physical and chemical behavior of the chemicals to be handled. Design engineers should call upon the laboratories to furnish any data which are required to complete their knowledge of a process. Often the need for such data is not evident until detailed design work has been started. All such data on the reactivity of chemicals involved can be made available to the operating department in a special "Safety Considerations Report." This report is discussed in more detail later in this article.

In the design of a plant or unit for the production of reactive chemicals, or of a process in which reactive chemicals are used in obtaining the final product, many features should receive especially close attention. We consider some of the most important of these in general terms in the following paragraphs.

► **Pipe System**—Pipe lines handling reactive chemicals should be as short and as direct as possible; equipment layouts should be prepared with this thought in mind. Cross-ties between lines, even though they are closed off with blind flanges or line blanks, should

Partial List of Reactive Chemicals—Table I

As defined here, reactive chemicals are those which will react vigorously with themselves, or decompose, either spontaneously or through the action of a catalyst, heat, pressure or light. They can usually be recognized by their chemical structure. The list also includes chemicals which react violently with water.

In general, there are three classes of materials which will usually—although not always—react with themselves under suitable conditions. These include compounds containing either a vinyl linkage, or a carbonyl linkage, as well as conjugated unsaturates.

A. Vinyl Compounds contain the group



Compounds such as vinyl chloride, CH_2CHCl ; vinylidene chloride, CH_2CCl_2 ; styrene, $\text{CH}_2\text{CHC}_6\text{H}_5$; and the acrylates, CH_2CHCOOR , will react quite readily with themselves, forming polymers of the type of $\text{CH}_2\text{CHCl}\cdots\text{CH}_2\text{CHCl}\cdots\text{CH}_2\text{CHCl}$. No measurable quantity of catalyst need be present although a significant quantity of a free-radical-producing catalyst such as peroxide, or a high temperature, is usually needed to start a dangerous reaction. Light also may cause reaction. Monomers in this group are usually inhibited chemically or by refrigeration.

B. Carbonyl Compounds contain the group



List I—The following list contains information on chemicals whose self-reactivity is quite certain. List II, below, shows a number of chemicals of questionable nature, or those suspected because of their structure.

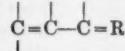
Key to Type of Linkage or Structure Contributing to Reactivity

TYPE	NAME	STRUCTURE
A	Vinyl	$\begin{array}{c} \\ \text{C}=\text{C} \\ \end{array}$
B	Carbonyl	$\begin{array}{c} \\ \text{C}=\text{O} \end{array}$
C	Conjugated, unsaturated	$\begin{array}{c} \\ \text{C}=\text{C}-\text{C}=\text{R} \\ \end{array}$
D	Self-reactants	$\begin{array}{c} \\ -\text{C}=\text{C}-\text{C}-\text{etc.} \\ \\ \end{array}$
E	Acetylenic and peroxide	$-\text{C}=\text{C}-, \text{R}-\text{O}-\text{O}-\text{R}$

Compounds such as acetaldehyde, CH_3CHO ; butyraldehyde, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$; and acetone, CH_3COCH_3 , when catalyzed with alkaline materials, and sometimes strong acids and amphoteric materials, will react to produce aldol-type condensations.

Their products may be catalyzed to take part in further reactions. Neutralizing the catalyst will stop or prevent the reaction, although the only certain way is exclusion of all catalytic materials.

C. Conjugated Unsaturated Compounds contain the group



Certain combinations of unsaturated bonds give molecules of this type an unusual reactivity. Compounds such as butadiene, $\text{CH}_2\text{CHCHCH}_2$; acrolein, $\text{CH}_2\text{CHCHCHO}$; crotonaldehyde, $\text{CH}_2\text{CHCHCHO}$; and acrylonitrile, CH_2CHCN , generally react similar to vinyl compounds although they may also react in other ways. Inhibitors are used with the more reactive monomers to prevent undesirable reactions.

D. Miscellaneous Self-Reactants not listed in the foregoing categories include such chemicals as hydrogen cyanide and ethylene oxide and ketene. Polymerization is effected by alkaline materials. Sulfuric acid in small amounts will inhibit the decomposition of HCN.

E. Spontaneous Decomposition occurs in materials such as peroxides, acetylene, acetylides and ethylene oxide. Peroxides offer little hazard in

dilute solution but may decompose explosively when concentrated. Peroxide-forming solvents may serve as polymerization catalysts for other chemicals.

The peroxides can be decomposed under controlled conditions but each case needs separate study. It is best to avoid forming them at all by strict exclusion of oxygen.

Acetylene can decompose with explosive violence. Safety measures include dilution with inert gases, using low process pressures and packing lines and equipment with heat-absorbing solid material. Acetylides are formed by reaction of acetylene with many metals including copper, silver, magnesium, mercury and the alkali metals. Copper acetylide may be formed on copper and copper-alloy equipment and is heat, shock and abrasion sensitive.

F. Chemicals Reactive With Water include acid anhydrides and halides, alkali metals and their oxides. In addition, concentrated acids and bases exhibit a large heat of solution and so should be diluted carefully, adding the chemical to the water. The acid anhydrides and halides (e.g., acetic anhydride or phosphorus oxychloride) react vigorously with water to produce the corresponding acid. The alkali metals (Na, K and Ca) react vigorously with water to form hydrogen and the corresponding hydroxide. The oxides react to form the hydroxides. Both metals and oxides will act similarly with compounds such as alcohols, organic acids and amines, which contain an active hydrogen.

COMPOUND	TYPE OF STRUCTURE	TYPE OF REACTIVITY
Acetaldehyde	B	Alkali-catalyzed condens'n.
Acetylene	E	Explosive decomposition
Acrolein	C	Vinyl polymerization and aldol condensation
Acrolein cyanohydrin	C	Vinyl polymerization
Acrolein dimer	B	Aldol polymerization, acid-catalyzed polymerization
Acrylic acid	C	Vinyl polymerization
Acrylonitrile	C	Vinyl polymerization
Allyl chloride	A	Vinyl polymerization
Allyl cyanide	C	Vinyl polymerization
Allylidene diacetate	A, B	Vinyl polymerization
Ammonium nitrate	—	Explosive decomposition
Bis (heptafluorobutyl) peroxide	E	Explosive decomposition
Butadiene	C	Vinyl polymerization
Butyl acetate	C	Vinyl polymerization
Butyraldehyde	B	Aldol condensation
Calcium acrylate	C	Vinyl polymerization
2-Chloropropionaldehyde	B	Aldol condensation
Chlorotrifluoroethylene	A	Vinyl polymerization

(Continued)

"REACTIVE" CHEMICALS . . .

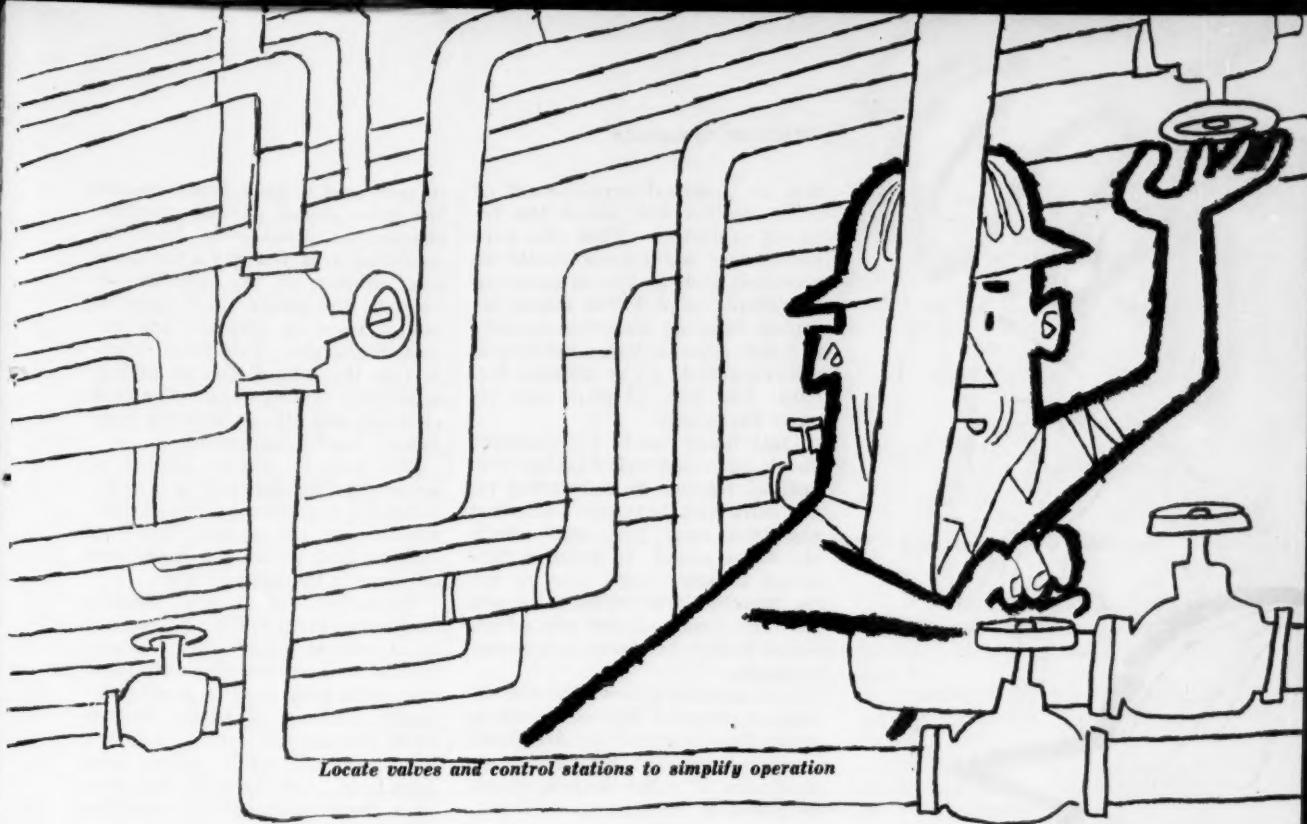
COMPOUND	TYPE OF STRUCTURE	TYPE OF REACTIVITY	COMPOUND	TYPE OF STRUCTURE	TYPE OF REACTIVITY
Copper acetylide	E	Explosive decomposition	Tert. butylhydroperoxide	E	Explosive decomposition
crotonaldehyde	C	Aldol condensation	tributyl phosphine	—	Spontaneous ignition in air
croton oil	B	Possible aldol condensation	tridecyl aldehyde	B	Spontaneous ignition in air
1, 3-Cyclopentadiene	A	Vinyl polymerization	valeraldehydes	B	Aldol condensation
Decyl acrylate	A	Vinyl polymerization	Vinyl acetate	A, B	Vinyl polymerization
Decyl aldehyde	B	Possible aldol condensation	Vinylacetylene	C	Vinyl polymerization, explosive decomposition
4, 4-Diacetoxy butyraldehyde	B	Aldol condensation	Vinyl acrylate	A, C	Vinyl polymerization
Diacetylene	E	Explosive decomposition	Vinyl allyl ether	A	Vinyl polymerization, ionic-catalyzed polymeriz'n.
Diacetyl peroxide	E	Explosive decomposition	Vinyl butyl ether	A	Ionic-catalyzed polymeriz'n.
Diallyl maleate	A, C	Vinyl polymerization	Vinyl butyrate	A, B	Vinyl polymerization
Dibenzoyl peroxide	E	Mild explosive decom.	Vinyl chloride	A	Vinyl polymerization
Diethyl ether peroxide	E	Explosive decomposition	Vinyl 2-chloroethyl ether	A	Ionic-catalyzed polymeriz'n
Dichlorobutene	A	Vinyl polymerization	Vinyl crotonate	A, C	Ionic-catalyzed polymeriz'n
Dichloropropionaldehyde	B	Aldol condensation	Vinyl 2-ethylhexanoate	A, B	Vinyl polymerization
Dichloropentadiene	A	Vinyl polymerization	5-Vinyl 2-ethyl pyridine	A	Vinyl polymerization
Diethyl ether peroxide	E	Detonation	Vinyl formate	A, B	Vinyl polymerization
Disopropyl ether peroxide	E	Detonation	Vinyl isobutyl ether	A	Ionic-catalyzed polymeriz'n
Diketene	C	Violent polymerization, hydrolysis	Vinyl propionate	A, B	Vinyl polymerization
Dilauroyl peroxide	E	Explosive decomposition	Vinyl propyl ether	A	Ionic-catalyzed polymeriz'n
Ditertiarybutyl peroxide	E	Explosive decomposition			
Divinyl sulfone	A	Vinyl polymerization			
Ethyl acrylate	C	Vinyl polymerization			
Ethylene oxide	D	Hydrolysis, polymerization, isomerization to acetaldehyde			
2-Ethylhexaldehyde	B	Spontaneous ignition in air			
2-Ethylhexyl acrylate	C	Vinyl polymerization			
Ethyl 1-propenyl ether	A	Ionic-catalyzed vinyl polymerization			
Formaldehyde	B	Condensation and polymerization			
Glutaraldehyde	B	Aldol condensation and polymerization			
Glyoxal	B	Condensation and polymerization			
2, 4-Hexadienal	C	Vinyl polymerization, aldol condensation			
Hexaldehyde	B	Aldol condensation			
Hydrazine	—	Explosive decomposition			
Hydrogen peroxide	E	Decomposition			
α -Hydroxyacetylaldehyde	B	Aldol condensation			
Isobutyl aldehyde	B	Aldol condensation			
Isoprene	C	Vinyl polymerization			
Isopropenyl acetate	A, B	Vinyl polymerization			
Ketene	D	Polymerization, hydration			
Methacrolein	C	Vinyl polymerization			
Methacrylic acid	C	Vinyl polymerization			
1-Methoxy-1, 3-butadiene	C	Vinyl polymerization, ionic-catalyzed polymerization			
Methylacetylene	E	Explosive decomposition			
2-Methylpentaldehyde	B	Condensation			
Nitro compounds	—	Explosive decomposition			
Peracetic acid	B	Explosive decomposition			
Perchloric acid	—	Explosive decomposition			
Piperylene	C	Vinyl polymerization			
Propadiene (allene)	A	Vinyl polymerization			
Propionaldehyde	B	Aldol condensation			
Pyruvic aldehyde	C	Polymerization			
Silver acetylide	E	Explosive decomposition			
Sodium perchlorate	—	Explosive decomposition			
Sodium sorbate	C	Vinyl polymerization			
Sorbic acid	C	Vinyl polymerization			
Styrene	A	Vinyl polymerization			
Succinaldehyde	B	Aldol condensation			

Compounds Reacting With Water

Acetic anhydride	Hydrolyzes
Acetyl chloride	Hydrolyzes violently
Aluminum alkyls	Hydrolyze explosively
Aluminum chloride	Hydrolyzes
Butyl magnesium chloride	Hydrolyzes violently
Calcium carbide	Hydrolyzes exothermically
Calcium oxide	Hydrolyzes exothermically
Chlorosulfonic acid	Hydrolyzes violently
Diethyl sulfate	Hydrolyzes
Diisobutyl aluminum chloride	Hydrolyzes violently
Epichlorohydrin	Hydrolyzes
Isopropyl titanate	Hydrolyzes
Maleic anhydride	Hydrolyzes
Phosphoric acid	Heat of solution
Phosphorus oxychloride	Hydrolyzes violently
Phosphorus pentoxide	Hydrates violently
Phosphorus tetroxide	Hydrates violently
Phosphorus trichloride	Hydrolyzes violently
Phosphorus trioxide	Hydrates violently
Propylene oxide	Hydrolyses
Silicon tetrachloride	Hydrolyzes violently
Sodium metal	Hydrolyzes violently
Sodium methylate	Hydrolyzes
Sulfuric acid	Reacts violently
Titanium tetrachloride	Hydrolyzes violently
Triisobutyl aluminum	Hydrolyzes violently

List II—Self-reactivity of materials in this list is questionable, or suspected because of structure. Those marked with asterisk (*) hydrolyze or hydrate.

Acetaldehyde	Ethyl acetoacetate
Acetone	2-Ethylbutyraldehyde
Acetone cyanohydrin	Ethyl cyanohydrin*
Butyraldehyde	2-Ethyl-3-propylacrylic acid
Butyric anhydride*	Ethyl silicate*
Crotonic acid	Hydrogen cyanide
Diacetone alcohol	Isobutyraldehyde
Diethyl maleate	Isopropyl sulfate
Di (2-ethylhexyl) maleate	Nickel carbonyl
2, 4-Dihydroxy 3, 3-dimethyl butyronitrile	Paraldehyde
1, 3-Dioxolan*	Potassium hydroxide*
	Sodium hydroxide*



be avoided, and there should be no provision for their addition in the future. Insofar as possible, such lines should be for one purpose only.

The lines should be designed, fabricated and installed so as to be self-draining. Where pockets are unavoidable, drain valves should be provided. If drain valves are used, provision should be made for the collection and disposal of the materials drained from the lines. Pipe lines which will be in potentially fouling service should be constructed and installed in such a way that they can be removed easily at regular intervals for inspection and cleaning. Trenches or pits in which reactive chemicals may collect and react with other chemicals should be avoided.

Important valves and control stations should be located in such a way that operation is simplified and chances of confusion are minimized. Apply these test questions: If an operator confuses two control stations, side-by-side, and operates the wrong valve, will a hazardous situation arise? If he operates two valves in the wrong order what will happen? What happens if a valve leaks? If it appears that potentially hazardous situations can occur very easily, consider installing interlocked valves, double-valves-and-vents, or other safeguards.

► **Process Vessels**—The size of process vessels which will contain reactive chemicals must be chosen with care. The choice will be influenced by several factors: For example, the capacity of some practical arrangement of relief devices should be adequate to relieve excessive pressure caused by uncontrolled reaction of the contents of the vessel. The amount of reactive material contained in a vessel should be small enough to permit rapid correction of minor operating errors.

Finally, the arrangement of process vessels should take into consideration the localizing of damage if an accident should occur. The use of spacing, of barricades, or the protection afforded by features of the terrain may be factors.

The design of process vessels for reactive chemicals should be considered on the basis of operating pressure, maximum operating pressure during a likely operating upset, and maximum explosion pressure. Sometimes it is possible to design a vessel to withstand explosion pressures—particularly if the initial pressure is low or if raschig rings or other packing materials are used to fill the vapor space. As in the handling of acetylene, such packing provides an internal "thermal flywheel" effect to minimize formation of hot spots.

When material in storage is heat-sensitive, some provision should be made for protecting the vessel in case of an exposure fire. Insulation is effective, and permanent water spray systems are often used.

Barricades around equipment containing particularly dangerous materials can be used if necessary to afford adequate protection. Such barricades should be designed to protect personnel and nearby equipment and piping. Operators should not be expected to enter the barricaded area during routine operation.

► **Relief Devices**—Adequate relief devices should be provided. Such devices may include safety valves, rupture disks, fusible-link valves, remote-operated valves, etc. Combinations of these should be provided for normal operation, as well as for emergency use. Such devices should be sized and set so that they will prevent, if possible, any further increase in pressure or reaction rate after they open. The required capacity of the relief devices should be calculated on the basis that an uncontrolled reaction could occur.

In selecting the type of relief device we must of course consider the specific relief problem, taking such factors as rate of pressure rise into account.

In some cases it will be found

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that no practical arrangement of relief devices will afford the required protection. When this happens, other safeguards should be provided, such as special sampling procedures coupled with means for rapidly dumping the entire contents to a safe place such as a flare stack, drowning tank, pit or disposal furnace. The disposal place may require barricades.

Heat input due to fire exposure should be considered, together with heat of reaction in calculating relief valve size. In theory, one might say that these two heat effects should be added. In practice, this would in some cases give an unrealistically large relief-valve size and the larger of the two effects would have to be chosen as a design criterion.

The hazards inherent in the operation of relief devices should be carefully analyzed. Additional facilities, such as piping for the discharge of relief devices, should be added if necessary.

It is, of course, important to note that the relief device itself should be the limiting factor in discharging the system pressure—not the discharge piping. Otherwise, the relief device although large enough in itself may be ineffective.

The set pressure of relief devices is usually a function of design pressure of the vessel protected. In some cases, however, a low set pressure may be desirable as a warning of an unsafe condition long before pressure has risen to the danger point.

In instances where vapor-phase relief requirements are excessive, it may be practical to dump the liquid contents of the vessel. This will create a new hazard in itself unless arrangements are made in advance for disposing of the material dumped. Such a system requires very careful planning.

All emergency relief devices should be protected from any conditions which might make them inoperative. Frequent offenders are fouling, corrosion and freezing. Piping downstream of safety valves should be viewed with suspicion if the material likely to be discharged tends to foul or freeze.

An example of what can happen occurred recently. A heated storage tank for high-boiling, toxic residues was equipped with a safety valve. To prevent exposure

of personnel to toxic fumes in case the valve should operate, the discharge was piped away from the operating area. One day a spontaneous reaction of the residues occurred. The safety valve operated and a foam of residues and gas was discharged. This foam solidified in the cold discharge piping, effectively sealing it off. The tank exploded and did considerable damage to nearby equipment.

One way to prevent fouling of necessary discharge piping is to arrange for a continuous flow of inert gas through the system. However, this method would not have been effective in the example cited.

Protection of safety devices themselves from fouling or freezing is of utmost importance. Various means, such as sweeping with inert gas, have been used to protect exposed surfaces of safety devices from polymer formation. Rupture disks beneath safety valves have been used. Nothing takes the place of a frequent inspection schedule. Safety devices requiring such a schedule should be made easily accessible.

► **Control Instrumentation**—Special emphasis must be given to instrumentation in systems involving reactive chemicals. Special interlocks and automatic features to minimize chances of human error should be provided. Such safeguards will be of value only if their function is fully understood by those using them.

Use of automatic devices to detect malfunctioning equipment, incipient reaction, loss of inhibitor, or unstable mixtures should all be considered. Such devices may be as simple as a temperature indicator or as complicated as an automatic gas analyzer. These should be arranged to actuate audible and visible alarms, and should be equipped with fail-safe features.

Automatic or manual equipment to introduce an inhibitor, diluent, or other reagent to slow down or stop a runaway reaction may be practical in some cases. The limitations of any such system should be determined and carefully explained to avoid a false sense of security.

An example of poor temperature control caused by improper instrumentation involved an installation where the pressure in an autoclave controlled the flow of coolant. The pressure lead to the coolant control

Arrange malfunction detectors to actuate audible and visible alarms



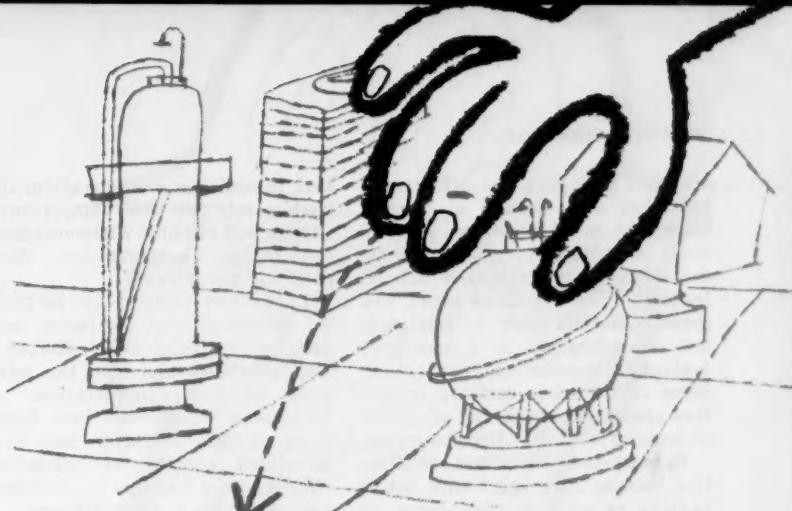
valve was located above a shut-off valve. One day the shut-off valve was closed in an effort to determine the source of a gas leak. This blocked the pressure lead so the cooling medium flow was cut off by the instrument. Within a few minutes the reaction was out of control. The autoclave would have ruptured except for the fact that valves, sight glasses, and a packing gland on the top dome blew out and relieved the pressure. Improper location of the pressure lead was the fundamental cause of the accident.

► **Inert Gas Systems**—Inert gas is very useful in a unit where reactive chemicals are processed. Vapors such as ethylene oxide can be rendered nonexplosive by dilution with many inert and noninert gases.

Inert gas headers, however, can be a serious source of contamination. The "other fellow" very frequently lets some of his chemical-in-process back up into an inert gas header serving the entire plant. Every possible effort should be made, when a plant or unit is designed, to eliminate the possibility of foreign materials entering any plant distribution system. When the consequences of contamination are particularly severe, special equipment should be added to assure the purity of inert gas and any other material that will come in contact with a reactive chemical.

The consequences of failure of inert gas should be analyzed, and additional equipment or special operating procedures devised to cover the situation.

► **Plant Layout**—When reactive chemicals are involved, good plant layout is especially important. Crowded processing areas should be



With reactive chemicals, good plant layout is especially important

avoided. If possible, systems handling reactive chemicals should be separated from equipment which contains other reactive chemicals or materials having a low autogenous ignition temperature.

► **The "Safety Considerations Report"**—In our company a report is prepared by the engineering department as part of each of its design projects. This report deals with process hazards and safeguards. Sections of the report are devoted to the following subjects:

- General process description.
- Discussion of special hazards.

- Discussion (and description) of equipment, instrumentation and alarms provided to avoid potential hazards.

- Suggestions regarding operating procedures for minimizing hazards.

- Discussion of the physical properties of products and intermediates, emphasizing reactive behavior.

- References to data and reports which will be of value to operating personnel.

This report is written whether or not reactive chemicals are involved.

Minimizing Sources of Trouble in Operation

Experience has taught many lessons about accidents and how they happen. There are almost as many different ways in which hazardous situations can occur as the number of such occurrences. Since all of the routes to danger cannot possibly be defined and discussed in an article such as this, a few of the more common causes of hazard will be considered in detail. These will

serve as examples to others whose responsibility it is to seek out and eliminate as many such potential process hazards as possible.

The specific examples discussed in the following pages are real. Since much can be learned from experience, the next section will record some of the lessons of experience for others to study.

► **Failure of Inhibitor**—Inhibitors

Physical and Chemical Properties Check List—Table II

Chemical formula

Explosive limits in air

Vapor pressure

Toxicity

Flash point

Freezing point

Autogenous ignition temp.¹¹

Coefficient of expansion

What are effective inhibitors?

What is the effective concentration range of inhibitors?

How can the inhibitor concentration be checked?

Are inhibitors ineffective above a certain temperature?

Will the material form peroxides?

What precautions must be taken to prevent peroxide formation?

How can peroxides be handled safely if they should happen to form?

Will the material react with itself?

How violent is the reaction?

What are effective catalysts?

What concentration of catalyst is required?

How can the presence of catalyst be detected?

How can catalysts be destroyed?

Do decomposition or polymerization products catalyze further reaction?

Will the material react violently with water?

Will the material decompose spontaneously?

What temperature is required for spontaneous decomposition?

Are diluents effective to prevent decomposition?

What is the effective concentration of diluent?

What other means are effective in preventing decomposition?

Will the material decompose on prolonged storage?

How do materials of construction affect stability in storage?

How can progress of decomposition be followed quantitatively?

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are used to insure the safe transportation and storage at normal temperatures of monomers such as vinyl chloride, styrene, vinylidene chloride, acrylonitrile and others. Inhibitors, in the usual sense, are those materials used in relatively low concentration in a monomer system to prevent polymerization. Some of the more common inhibitors are alkyl amines and alkylated or nonalkylated dihydroxybenzenes.

In most cases inhibitors are effective because they react with active centers as soon as they form, or destroy traces of catalyst that enter the system. "Active centers" are the energized fragments or starting points for chain growth in polymerization. They may be generated by exposure to light or heat. Traces of peroxide catalyst may result from the absorption of oxygen and subsequent combination with the monomer. As it functions, the inhibitor is gradually consumed.

To insure against inhibitor loss, such precautions as exclusion of light and elimination of traces of oxygen from inert gas systems should be considered. (However, oxygen is sometimes an inhibitor. For example, inhibited acrylate monomers must contain some oxygen as well as some conventional inhibitor such as hydroquinone.

But, in sufficient concentration, and particularly at low temperature, oxygen will combine with monomers—including acrylates—to form catalytic peroxides.)

Laboratory tests should be made to determine the maximum temperature at which the inhibitor is still effective—and also the minimum effective concentration. As mentioned before, the best insurance against inhibitor loss is a scheduled routine of laboratory checks before transfer to plant storage and during plant storage.

Two monomers capable of copolymerization should not be casually mixed in the belief that no reaction can occur because of the presence of inhibitor. There are instances in which inhibitors are effective in monopolymerization but not in copolymerization. Examples of this are styrene-maleic anhydride and vinyl chloride-acrylonitrile. The possibility of such behavior should be checked in the laboratory before mixing monomers outside reactors.

In addition to inhibitor loss, another cause of inhibitor failure can be improper selection of inhibitor. A case involving recognition of this fact is worth mentioning.

One weekend recently, a shipping department employee started to load a tank car of vinyl chloride.

The car was for a new customer who had specified the kind and amount of inhibitor to be used. Since the inhibitor specified was not mentioned in the references available to the shipping department, there was no way to tell whether the mixture would be safe to ship. The tank car loader might have assumed that the customer knew what he was doing, loaded the car, and said nothing about it. But he did not.

Instead, he called the department head at his home, but could obtain no positive assurance that the mixture was safe. He then called several others, including a research chemist, seeking the assurance he needed. Only after laboratory records were searched and it was ascertained that the mixture was indeed safe did he fill the car and send it on its way. This is a fine example of the proper attitude to have when dealing with inhibitors for reactive chemicals.

► **Poor Temperature Control—** Poor temperature control is an obvious invitation to a hazardous situation in systems handling reactive chemicals. This is true whether such control is obtained in storage tanks, pipe lines, stills, or reactors. What are some of the causes of poor temperature control?

Consider a "near miss" which

Potential Sources of Trouble Check List—Table III

- | | |
|--|--|
| Does everyone in my group know his chemical? | Can the vent and purge gases for this unit be dangerously contaminated in another unit? |
| What would happen and what should be done if— | When equipment is changed from one service to another, are any of the following points not clearly explained in operating instructions? |
| Electric power fails?
Cooling water fails?
Refrigeration fails?
Instrument air fails?
Pressure gets out of hand?
Water leaks into the process?
A cooler or condenser plugs up?
An inhibitor pump breaks down? | Cleaning and inspection of equipment and piping?
Revised temperature and pressure limitations?
Review of piping arrangement for the new service? |
| Are the operating instructions clear and explicit? | What would happen if the materials in two adjacent compartments of a multicompartment tank or barge were to mix? |
| Do the operating instructions say what to do if something goes wrong? | Does the shipping department have special instructions for the handling of reactive chemicals? |
| Are efforts made immediately to determine the cause of unexpected phenomena such as: | Do all shipping personnel understand why these special instructions are important? |
| A drum of product "gone solid."
A process or transfer line plugged with polymer.
Unusual discoloration of material in storage.
Unusual rise in temperature or pressure. | Do the special instructions include procedures for cleaning shipping containers? |
| Are routine samples taken to make sure reactive chemicals are uncontaminated and properly inhibited? | Do they clearly explain that some cleaning compounds are dangerous contaminants for some reactive chemicals? |
| Are any of the following undesirable situations present in my system in which reactive chemicals are processed: | Are loading and unloading spots for reactive chemicals isolated from spots where dangerous contaminants might be handled? |
| Cross-tied transfer lines or pump headers?
Dead-ended pipe, pocketed lines, unused branches?
Malfunctioning instruments in critical services?
Confusing pipe and valve arrangements? | Have strict rules been laid down concerning the handling of a new material at or near a spot used for loading or unloading a reactive chemical? |

occurred in a resin plant. A non-indicating, variable-range temperature transmitter had been set (for process reasons) at a temperature lower than the indicated chart temperature range. The chart could not be replaced, so the change was noted on a sign attached to the indicating instrument. In the rush of starting up the unit, the instrument was rechecked and inadvertently reset to read the indicated chart temperature. As a result, operation was started at a temperature higher than normal.

The resulting higher-than-normal pressure was attributed erroneously to the presence of inert gas. Operators did not recognize the true situation until a polymer analysis indicated that the temperature must be high. Fortunately, in this case, the reaction rate did not exceed the operating limits of the equipment, but a financial loss did occur because of off-grade resin.

This situation would have been avoided if an additional temperature indicator had been in use, if the warning sign attached to the existing indicating instrument had been more obvious, or if the situation had been adequately explained.

Instrument problems are a sufficiently common source of danger so that a system for frequently (or constantly) checking key temperature controls and indicators should be provided. The use of the wrong chart on a temperature instrument may seem a remote possibility, but in units where a number of variable-range instruments are used, this problem becomes one that requires constant attention.

An auxiliary means for observing temperature is essential insurance, particularly where large quantities of reactive material are being stored or processed. The trend in design toward the use of non-indicating, variable-range transmitting instruments makes supplementary devices even more necessary because loss of air supply in such systems means loss of temperature indications. Temperature-actuated alarms are one such supplementary device.

Proper location of thermowells is a matter of very great importance. A thermowell installation should always be in a high-velocity fluid stream; it should not be close to a steam, a nitrogen or an air sparger; it should not be subject to atmospheric temperature



Poor temperature control invites a hazardous situation

changes in storage tanks, process lines, or reactors. Dual installations may be valuable and should be considered. Improperly installed thermowells are almost sure to result in poor temperature control.

Poor heat transfer can also be the cause of poor temperature control. Some conditions that result in poor heat transfer are rust, scale, or polymer on heat transfer surfaces; accumulation of solids around thermowells; change in heat-transfer properties as reaction progresses; and accumulation of noncondensable gases in a cooler-condenser.

The first problem can usually be handled by frequent inspection and cleaning. If inspection is difficult or impossible, inlet and outlet temperature indicators in the cooling medium are useful to determine the need for cleaning in advance of trouble. Modified agitation or circulation to give higher flows past cooling surfaces has been used to minimize this problem.

Accumulation of scale or other solids around a thermowell eventually leads to poor temperature control and possible loss of reaction control. Thermowells should be placed in a region of high flow to keep this trouble at a minimum. Frequent inspections should be made when fouling is suspected.

In some operations, polymerizations in particular, the physical properties of the mixture in process change radically as the reaction progresses. Viscosity has a profound effect on heat transfer. Although initial viscosity conditions

may be acceptable for adequate heat transfer, a large viscosity increase during a reaction can reduce heat transfer rates to such an extent that reaction rate control is lost. Heat transfer rates at the highest expected viscosity should always be checked before a new reaction is tried.

Another point to consider is the effect of cooling-medium temperature on fluid viscosity, particularly when jacketed vessels are used for reactions. There is a possibility in some systems that the cooling medium could be at a temperature low enough to cause a large viscosity increase in the film near the cooling surface inside the reactor. This would reduce the heat transfer rate. When heat transfer is borderline because of viscosity, this could be critical.

The temperature difference between reactants and coolant is important from still another standpoint. If this difference is too great, control of the reaction will be unstable. It works like this: Suppose, for some unknown reason, that a few particles of material begin to react at an accelerated rate (a "hot spot" forms). The local temperature rises an incremental amount, requiring an increase in the rate of heat removal.

Now, if the normal operating temperature difference is large, the percentage difference in temperature differential will be small; but if the normal temperature difference is small, then the percentage increase will be relatively larger so there will be a greater increase

in heat removal. For example, if the normal temperatures are 90 C. for the reactants and 30 C. for the coolant, then a 10° rise at a hot spot will be only 10/60 or 16.7%, whereas with normal temperatures of 90 C. and 70 C., a 10° rise would be 50% of the differential.

Thus, with too great a normal temperature difference, the increase in rate of heat removal from a hot spot will be less than the increase in rate of heat generated by the faster reaction at the hot spot. The reaction will then go out of control. The safe temperature difference for controlling any reaction can be calculated thermodynamically.

If adequate heat transfer depends on agitation, failure of the agitator will result in hazard.

Poor temperature control can also be caused by an accumulation of noncondensable gases in a reflux condenser used to remove heat of reaction. Closed systems should always be equipped with a condenser vent for elimination of noncondensables. A process line supplying noncondensable gas to a reactor should be blanked or provided with a double-valve-and-vent during the reaction period.

A dangerous situation can also occur when an exposed heating surface is present in a kettle containing a reactive chemical. This can happen when the liquid level falls below the jacket line in a jacketed kettle, or when the liquid level falls considerably below the coils.

► **Inadequate Cleaning of Equipment**—Inadequate cleaning of equipment and process lines is one of the more commonplace occurrences which can lead to serious trouble in systems handling reactive chemicals. This is true for at least two reasons: Vital equipment may become inoperative because of fouling; and catalytic quantities of material allowed to remain in equipment or piping may be hazardous subsequently.

Even though equipment is used continuously in only one service, a regular inspection and cleaning schedule should be set up if fouling occurs, or if it is likely to occur as the result of operating upsets of short duration. This is particularly important if the polymers formed are catalysts for further polymerization. This is true, for example, in the case of HCN.

When equipment is to be used

Inadequate cleaning can lead to serious trouble



interchangeably for various processes, the importance of careful cleaning and inspection cannot be overemphasized.

Consider the case of a "near miss" which occurred recently. A quantity of wet, crude hexadienyl was transferred by tank truck to the unit for redistillation. When the first 200 gal. had been charged to the kettle, an unusually high kettle temperature was noticed. The operators immediately dumped this material to the sewer, as they thought some caustic had been left in the still. They then boiled out the still with acetic acid.

After charging the remaining hexadienyl to the still, distillation proceeded smoothly for 22 hr. At this time, however, the make stopped, and a kettle temperature much higher than the usual boiling point of hexadienyl would produce no overhead. The kettle was cooled and opened. The residue had solidified to a coke. Analysis of the coke showed it to contain nitrogen.

The still had previously been used for the distillation of aniline, while an associated storage tank had been used for monoisopropanolamine. Both items had been cleaned before the hexadienyl distillation was started, but the transfer line between the tank and the still had apparently been overlooked.

Laboratory tests showed that a reaction of explosive violence results from mixing 2% of monoisopropanolamine in hexadienyl; a slightly lower concentration causes formation of coke such as that found in the kettle. It appears that only the quick action of the oper-

ators who dumped the first part of the charge (which contained most of the amine contaminant) to the sewer prevented an uncontrolled reaction and perhaps an explosion.

When a system is changed from one service to another, it is important to consider the last operation and determine how serious the consequences of a poor cleaning job would be in the next operation.

In cases where pumps and pipe lines are used interchangeably for materials which are dangerous when mixed, the only safe procedure is to disassemble the piping or pump to make sure that no residual material remains in trapped sections, valve bonnets, behind orifice plates, or undersized gaskets.

Tanks, kettles, reactors, and heat exchangers also should be examined upon change of service to eliminate contaminating materials in dead-ended nozzles and behind valves leading to the vessel. Heat transfer surfaces should be checked for fouling. Plugged heat exchanger tubes can collect dangerous contaminating liquids and solids.

Still columns equipped with bubble caps can retain large quantities of contaminant if drain holes are plugged. Solids often build up on the trays and resist cleaning, thus remaining as potentially dangerous contamination in the succeeding operation. Tray-by-tray inspection is in order if the change-over involves a particularly dangerous reactive chemical.

► **Hazards in System Conversion**—In addition to hazards resulting from the inadequate cleaning of equipment and piping, dangerous

conditions may arise in converting a system from one service to another because of unforeseen equipment limitations. Equipment may be inadequate for these reasons:

- Heat removal capacity, which was adequate for the last operation, may not be for the new one. Heats of reaction, reaction rates and heat removal capacity should be calculated carefully before an existing system is used for a new operation.

- Materials of construction may cause reactions in storage systems and uncontrollable reaction rates.

- The venting requirements for control of a "run-away" reaction may be higher for the new chemical. Rupture disk sizes, safety valve settings and vent line sizes should be rechecked carefully.

Hazards of Inadvertent Mixing
—Processes in which alkaline, acidic, or peroxidic materials must be used near or in conjunction with reactive chemicals invite the constant threat that uncontrolled mixing may occur. Although careful instruction may be given to prevent such an occurrence, the only sure way to prevent inadvertent mixing is to keep all transfer lines separated and to make the common tie-in point (such as a reactor) a make-and-break type of connection for one or all chemicals involved.

Where it is not practical to keep the materials separated by disconnecting a line, other devices may prove effective. For instance, in such cases as feeding an oxidizing agent to a polymerization, or caustic to an aldol condensation, the control of concentration of oxidizing agent or caustic solution, and the enforcement of a safe limit on feed

rate by limiting pump capacity, have been found useful.

Excessive water leakage into anhydrides, concentrated sulfuric acid, caustic, alkali metals, etc., from heating or cooling systems has occurred and caused considerable trouble. A rigorous inspection program should be set up and followed to guard against this.

Those who handle reactive chemicals must be continually on the alert to recognize situations which are potentially hazardous.

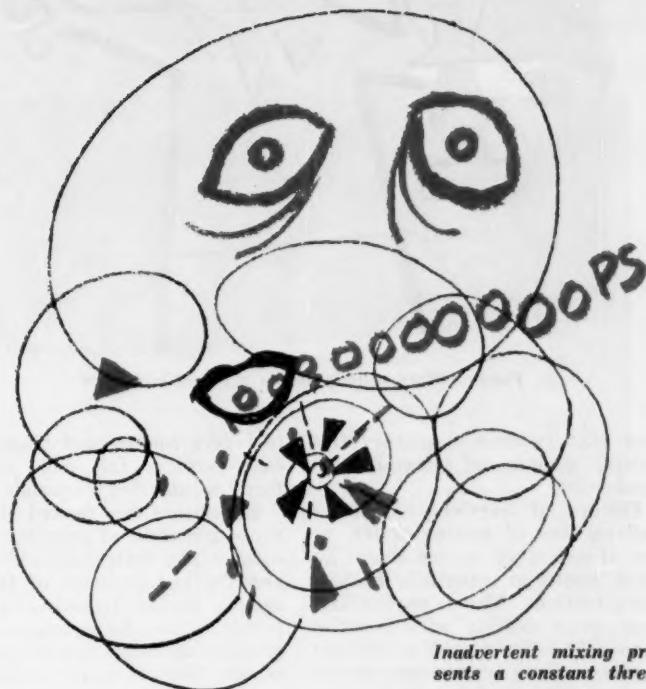
For example, an operator at a barge dock recently reported an episode which illustrates very well

how hazardous situations can arise when people are not reactive-chemical conscious. This man was measuring temperatures of materials in a multicompartment barge, using a thermometer in a small sample bottle fastened on a stick. After obtaining the temperature in one compartment, he went on to the next. The bottle contained a small amount of the first material when it was immersed in the second compartment. To the operator's surprise, the temperature in the second compartment was apparently 40 F. higher than the first.

Investigation of this strange behavior revealed that the first material was an alkanolamine; the adjacent compartment contained an unsaturated aldehyde. The alkanolamine had caused immediate violent reaction when it came in contact with the aldehyde. Not much imagination is needed to picture the consequences of a leak.

Resulting from this discovery was a directive listing classes of compounds which can and cannot be handled safely together in multicompartment barges. The rules for barges apply equally for multicompartment tanks which are frequently specified nowadays when many different materials must be stored in a single area.

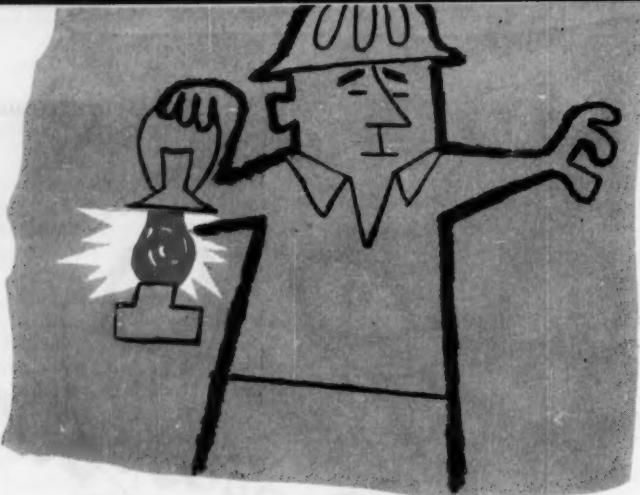
Inadvertent mixing through com-



Safety Data Sheets on Reactive Chemicals—Table IV

Obtainable from Manufacturing Chemists Association, Washington, D. C. Prices of all are 30¢, except SD-25 on HF which is 50¢.

Acetaldehyde (1952)	SD-43	Hydrocyanic acid (1957)	SD-67
Acetic anhydride (1947)	SD-15	Hydrofluoric acid (Rev. '57)	SD-25
Acetylene (Rev. 1957)	SD-7	Hydrogen peroxide (Rev. '55)	SD-54
Acrylonitrile (1949)	SD-31	Nitrobenzene (1948)	SD-21
Aluminum chloride, anhydrous (1956)	SD-62	Perchloric acid solution, preliminary (1947)	SD-11
Butadiene (Rev. 1954)	SD-55	Phosphoric acid (1958)	SD-70
Calcium carbide (1948)	SD-23	Phosphoric anhydride (1948)	SD-28
Caustic potash (1947)	SD-10	Phosphorus oxychloride (1948)	SD-26
Caustic soda (1947)	SD-9	Phosphorus trichloride (1948)	SD-27
Chlorosulfonic acid (1949)	SD-33	Sodium metal (1952)	SD-47
Dimethyl sulfate (1947)	SD-19	Styrene monomer (Rev. '51)	SD-37
Ethylene oxide (1951)	SD-38	Sulfuric acid (Rev. '52)	SD-20
Formaldehyde (Rev. 1952)	SD-1	Vinyl chloride (1954)	SD-56



Power failure usually means a potential hazard

mon vent systems is another frequently encountered source of contamination.

► **Failure of Services**—A power failure, loss of cooling water, or loss of any other service almost always results in potentially hazardous situations. This is particularly true when dealing with reactive chemicals. Considerable thought should be given to the consequences. In anticipation of failure of services, procedures should be developed that will prevent not only buildup of excessive pressures, but also dangerous accumulation of hazardous gases or liquids in the surrounding areas as a result of dumping or venting.

Some usual methods for emergency control of reactions are:

- Dilution of the reaction mixture with an inert, cold medium.
- Addition of an inhibitor. (However, the addition of inhibitor to a reacting mixture should be investigated thoroughly before use. There are instances in which addition of an inhibitor, which is a reducing agent, to emulsion-type polymerizations, has resulted in an increased reaction rate caused by a reaction involving the reducing agent and the polymerization catalyst.)

- Venting to atmosphere to cool the charge by evaporation.
- Dumping the charge out of the reactor into a prepared control area.

Attention should also be given to the design of process equipment

to reduce fouling and plugging in case services fail and polymers form or slurried materials settle.

Experience has proved that advance planning of emergency procedures can materially reduce the severity and duration of the hazardous period following a plant power failure. Experience also emphasizes the importance of splitting power loads between independent sources and of providing some steam-driven equipment to supplement motor-driven equipment in critical services.

One technique, which has been

used to minimize the problem of reaction control when an emergency occurs, is to hold the total amount of reacting material at any particular instant to such a low level that loss of control would result in only a minor pressure surge.

► **The Human Element**—It is doubtful that any engineer will ever design a process or set up an operating procedure which will be entirely independent of human beings. Therefore, the human element must be taken into consideration, especially when reactive chemicals are involved. Human errors should be few and far between if:

- Everyone knows exactly what is going on.
- Clear, concise instructions are written.
- Confusing valve and piping arrangements are eliminated or carefully tagged.
- Dangerous materials are kept separated.
- Unused piping, cross-ties, dead-ended lines and "temporary" lines are eliminated.
- Instructions are reviewed periodically to make sure they are still understood and followed.



ARTHUR B. STEELE

On his graduation in chemistry from University of Wisconsin in 1941, Dr. Steele joined Mellon Institute under a Union Carbide Chemicals-supported fellowship, meanwhile working at University of Pittsburgh toward the PhD which he received in 1949. Six years later he moved to New York as Carbide's manager of Technical Service as an industry specialist in several widely diverse fields.



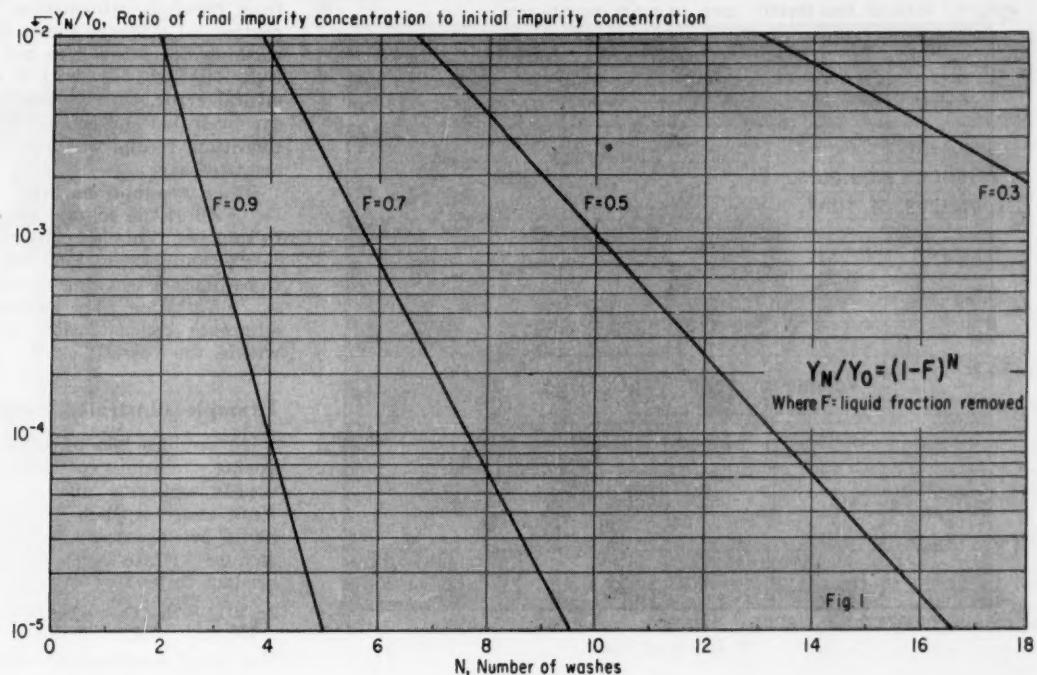
JAMES J. DUGGAN

For many years Union Carbide Chemicals Co.'s expert on fire protection, fire protection engineering and fire research, Duggan has been with the company for 35 years. Working out of the South Charleston, W. Va., plant, for the past four years he has had company-wide direction of all safety and fire protection activities, including classification of hazards of "reactive" and other chemicals.

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Use this chart to find number of washes for batch method.



Find Wash Liquid Requirement Fast

Method applies to either batch or continuous washing of solids when wash liquid removes soluble impurity from product.

TIMOTHY KIRBY, Metal & Thermit Corp., Rahway, N. J.

REMOVAL of a soluble impurity from an insoluble product requires the addition and decantation of relatively large volumes of wash liquid. Using a minimum of data, here is a graphical method which gives rapid evaluation of the amount of wash liquid used in batch or continuous methods.

TIMOTHY KIRBY is a process engineer in the research and development group of Metal & Thermit Corp. His work includes product and process development of organometallic compounds.

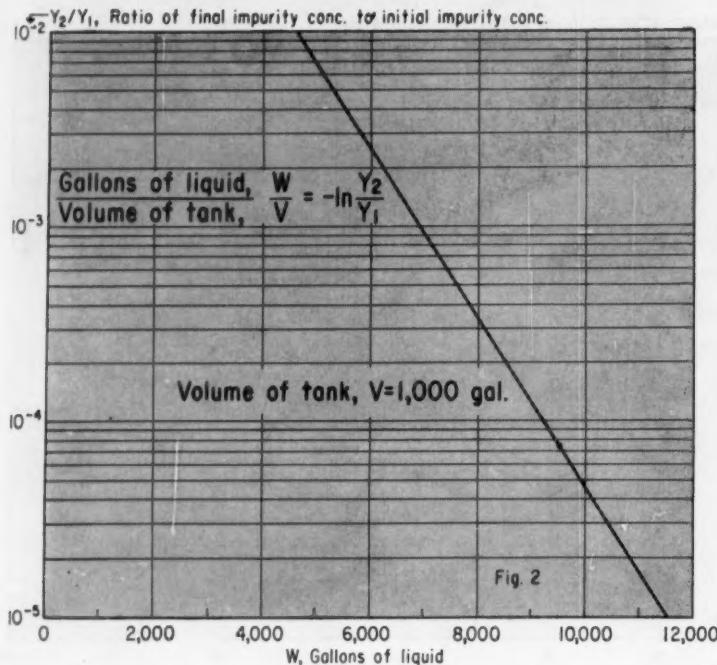
Batch washing consists of a four-step cycle: addition of wash liquid, agitation, settling and decantation. Most frequent application of batch washing is removal of a soluble impurity or byproduct from an insoluble product which may be formed by precipitation.

Continuous washing involves addition and removal of wash liquid from an agitated tank. The outlet stream flows through a suitable filter medium. Continuous washing finds applications similar to those of batch washing but is not as common.

Batch Washing of Impurities

In batch washing operations, let Y_1 = amount of soluble impurity present after decantation 1, Y_N = amount of soluble impurity present after decantation N , Y_0 = amount of soluble impurity initially present. Express any concentration Y as lb. of impurity/lb. of product.

Also, let F = fraction of liquid removed with each decantation. This fraction remains reasonably constant and can be determined by observing settling in a graduated cylinder. However, if large changes

For continuous method, chart gives volume of wash liquid.Fig. 2 is a graph of Eq. (4) when $V = 1,000$.**Wash Liquid Requirements**Dividing Eq. (2) by Y_o gives:

$$Y_N/Y_o = (1 - F)^N \quad (5)$$

Taking the natural log of both sides of Eq. (5) gives:

$$\ln(Y_N/Y_o) = N \ln(1 - F) \quad (6)$$

The following equation is now written relating batch and continuous washing:

$$\ln(Y_N/Y_o) = \ln(Y_1/Y_1) \quad (7)$$

Substituting from Eqs. (2) and (4) into Eq. (7) gives:

$$N \ln(1 - F) = -W/V \quad (8)$$

Rearranging and dividing Eq. (8) by F gives the equation, which is necessary for basic cost and rate studies, for batch and continuous methods.

$$\frac{W}{NFV} = -\frac{\ln(1 - F)}{F} \quad (9)$$

Here NFV is the amount of wash liquid used in batch washing.

These relationships assume that there is no co-precipitation of the impurity with the product. This

$$VdY = -YdW \quad (3)$$

where V = volume of liquid in vessel; Y = concentration of soluble impurity; and W = volume of wash water added. Integration of Eq. (3) yields:

$$W/V = -\ln(Y_1/Y_1) \quad (4)$$

is the riskiest assumption. Its validity can be ascertained only from previous information. If experimental evidence shows that the washing operation does not follow Eqs. (2) or (4) within experimental error, then co-precipitation can well be suspected. For this condition, special washing methods are necessary.

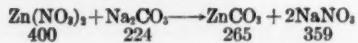
Other assumptions are:

- All of the soluble impurity is in solution. This is ordinarily valid in a washing operation. Otherwise, it becomes a leaching operation.

- Agitation is sufficient to eliminate concentration gradients within the vessel.

Example Illustrates Methods

To produce 265 lb. of zinc carbonate, solutions of sodium carbonate and zinc nitrate interact. How many washes or gallons of liquid are necessary to reduce the sodium nitrate level in the final product to 0.01%?



For batch washing, $Y_o = 359/265 = 1.35$; $Y_s = 0.0001$ and $Y_s/Y_o = 0.000074$. Next, we determine the fraction of liquid F removed in each decantation by observing the settling in a graduated cylinder. For this problem, $F = 0.7$.

Referring to Fig. 1, for $F = 0.7$ and $Y_s/Y_o = 0.000074$, $N = 7.9$ washes. Hence, eight washes are necessary.

For continuous washing, an agitated reactor of 100 gal. capacity is used. The liquid containing the impurity passes through a vacuum leaf-type filter. When $Y_s/Y_1 = 0.000074$, $W = 9,500$ gal. for the 1,000 gal. volume as shown in Fig. 2. Since our volume is 100 gal., $W = 950$ gal. of water. Hence, 950 gal. of liquid must be drawn through the filter before the concentration of sodium nitrate reaches an acceptable level in the zinc carbonate product.

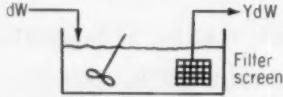
From Eq. (9), we can determine the ratio of water used for each method as follows:

$$\frac{W_c}{W_b} = \frac{\ln(1 - F)}{F} = \frac{\ln(1 - 0.7)}{0.7} = 1.72$$

The ratio of 1.72 indicates that the continuous method uses 72% more water. If the slurry can be handled at a decreased volume, water necessary for continuous washing decreases.

Continuous Washing Methods

When wash liquid is added and removed continuously to a homoge-

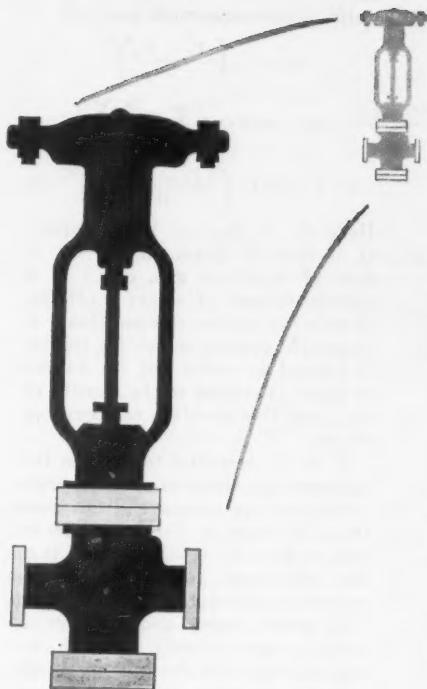


nous slurry such as the agitated tank with filter as shown above, the material balance on the soluble impurity is given by:

$$VdY = -YdW \quad (3)$$

where V = volume of liquid in vessel; Y = concentration of soluble impurity; and W = volume of wash water added. Integration of Eq. (3) yields:

$$W/V = -\ln(Y_1/Y_1) \quad (4)$$



How to Select . . .

Control Valve Size

Valve and process characteristics, as well as pressure drops in pipeline and valve, plus specific gravity, viscosity and volume of flow are all factors you must consider.

WERNER G. HOLZBOCK, CPE Controls, Inc., Chicago, Ill.*

PRESSURE drop, flow and specific gravity are the determining factors in selecting a suitable size for control valves. Other factors such as type of fluid, gas or liquid, critical flow conditions for gases and vapors and viscosity of liquids, influence valve size. Before selecting final valve size, valve and process characteristics must match to compensate for nonlinearities in the control valve and process. How all these factors contribute to the ultimate selection of correct valve size is the subject of our discussion.

One of the most useful factors to determine the size of a valve is the flow coefficient or C_v factor. Practically all manufacturers supply C_v factors for their valves. These factors form the basis for all calculations. The C_v factor is the number of U. S. gallons of water per minute at 60 F. that flow through a valve at maximum opening and a pressure drop of 1 psi. measured in the inlet and outlet pipes directly adjacent to the valve body.

Basic flow formula for liquids is

* To meet your author, see *Chem. Eng.*, March 9, 1959, p. 140.

$$Q = kA \left(\frac{P_1 - P_2}{G} \right)^{0.5} \quad (1)$$

where Q is flow rate, gpm.; P_1 and P_2 are pressures measured across the valve, psi.; G is specific gravity referred to water; k is a constant and A is port area of valve, sq. in. Since $G = 1$ for water, Eq. (1) becomes

$$Q = kA (P_1 - P_2)^{0.5} \quad (2)$$

Furthermore, by assuming that pressure drop ($P_1 - P_2$) equals 1 psi., Eq. (2) simplifies to

$$Q = kA \quad (3)$$

Eq. (3) expresses the flow of water through a valve of port area A with a pressure drop of 1 psi. However, this is the definition of C_v which can be substituted for kA . Hence inserting C_v for kA in Eq. (1) gives

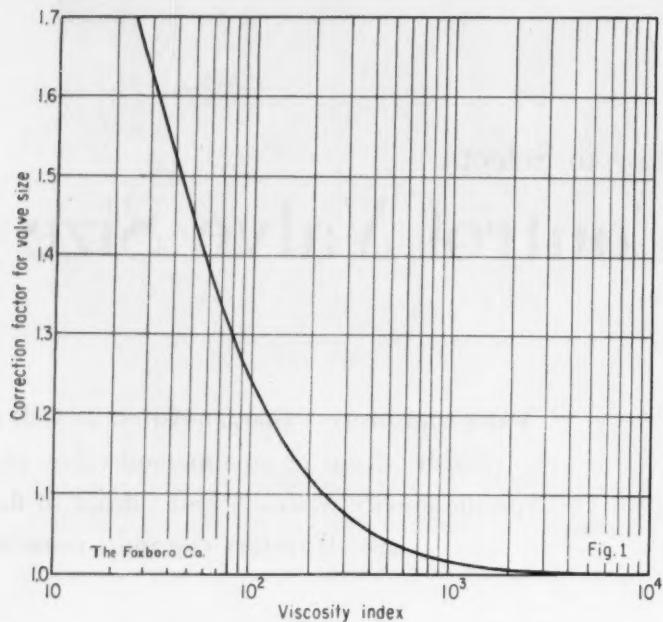
$$Q = C_v \left(\frac{P_1 - P_2}{G} \right)^{0.5} \quad (4)$$

For example: a standard 1-in. double seated valve may have a C_v factor equal to nine. Suppose the pressure drop across the valve is 64 psi. and the liquid has a specific gravity of 1.44. In this case, $Q = 9(64/1.44)^{0.5} = 60$ gpm.

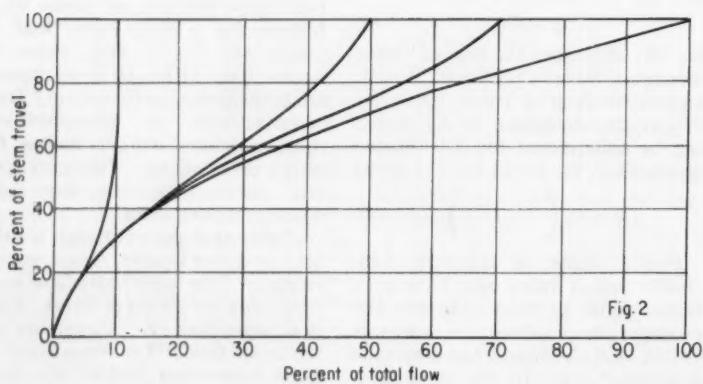
Valves are rated by the pipe sizes of their end connections. The maximum flow area which they provide must be in the same order of magnitude as the pipe size. Since, area is proportional to the square of the diameter, a 2-in. valve passes about four times the flow of a 1-in. valve. Again, a 4-in. valve passes about four times the flow of a 2-in. valve or 16 times the flow of a 1-in. valve.

The C_v factor which is a flow coefficient changes in the same manner. Hence, remembering that a 1-in. valve has a C_v of about 10, it follows for a 2-in. valve that C_v equals 40. For a 4-in. valve, C_v equals 160. Although these figures are only approximate and vary from manufacturer to manufacturer, these numbers usually suffice for rough calculations. For more precise calculations, use the valve manufacturer's data.

Fluids that pass through a valve may be either liquids, steam, vapors or gases. The same basic flow equation holds for all three fluids. Practical equations are in common use for each fluid. The equations include conversion factors which allow for direct insertion of the flow

Increase Valve Size for Viscous Liquid Flow**Flow Control Depends on Minimum Pressure Drop in Valve**

Line ΔP ...	99%	75%	50%	0%
Valve ΔP ...	1%	25%	50%	100%



rates when expressed in the usual units. These equations are:

$$Q_L = C_v \left(\frac{P_1 - P_2}{G} \right)^{0.5} \quad (5)$$

$$Q_S = 63.5 C_v \left(\frac{P_1 - P_2}{G} \right)^{0.5} \quad (6)$$

$$Q_G = 1,360 C_v \left(\frac{(P_1 - P_2) P_1}{G T} \right)^{0.5} \quad (7)$$

Here Q_L is flow of liquid, gpm.; Q_S is flow of steam, lb./hr.; Q_G is flow of vapor or gas, cfm.; V is specific volume of steam, cu.ft./lb., at existing upstream conditions; G is specific gravity which for liquids is related to water but for vapors or gases is related to the density of air; and T is absolute temperature of gas ($^{\circ}\text{F.} + 460$).

It is not essential to express the pressures as absolute or gage pressures for the pressure drop since the difference is the same. However, in Eq. (7), it is important that the additional factor P_1 be expressed in absolute pressure units.

In steam, vapor and gas flow, a critical flow condition will be reached when the absolute upstream pressure is twice the downstream pressure. Any further increase of the pressure drop will not change the maximum flow because turbulent conditions, set up in the valve by the high pressure drop, oppose any increase of flow. Hence, where this condition is reached, a practical assumption is made. Pressure drop becomes simply 50% of the upstream pressure in psia.

Examples Illustrate Methods

Assume that a 2-in. valve, whose C_v is 40, controls steam flow. Upstream pressure is 80 psig. and pressure drop is 36 psi. If specific volume of the steam is 5.5 cu.ft./lb., the valve when fully open passes

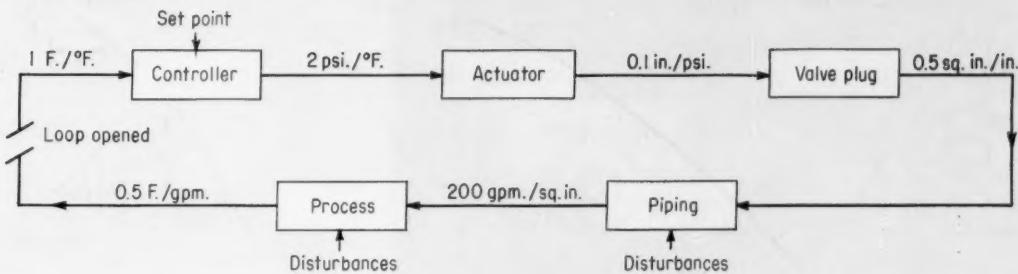
$$Q_S = 63.5 \times 40 (36/5.5)^{0.5} = 6,500 \text{ lb./hr.}$$

Suppose the pressure drop increases to 50 psi. This value is greater than 50% of the absolute upstream pressure which is 47.5 psia. Hence, steam flow is now 7,500 lb./hr. which is the maximum amount of steam that can pass through the valve at 80 psig. upstream pressure.

Assume, now, a gas flow where $G = 0.81$, temperature = 440 $^{\circ}\text{F.}$, upstream pressure = 81 psia. and pressure drop = 36 psi. Using Eq. (7), we find $Q_G = 108,800 \text{ cfm.}$

When liquids go through a valve,

System Characteristics May Cause Nonlinear Behavior in Control Valve



they pass from a higher to a lower pressure. At the lower pressure, the liquid may vaporize. If such conditions exist, it generally suffices—for practical purposes—to choose a valve one size larger than calculated for the liquid. It is important to expand the piping rapidly on the downstream side to take care of the expansion of the fluid.

Correct for Viscosity

All fluids possess a quality known as viscosity, but this property only becomes important in control valve sizing when handling highly viscous liquids. For such cases, the Foxboro Co. uses the following method.

First, the valve size is calculated under the assumption of nonviscous flow. Then a viscosity correction factor is established for the viscous conditions. Calculated valve size is multiplied by the viscosity correction factor to get the corrected valve size. It is necessary for this calculation to know the viscosity in stokes or saybolt seconds universal at the flowing temperature.

Use these equations to correct for viscosity:

$$K = \frac{31.6 Q_L}{d \times V_s} \quad (8)$$

$$K = \frac{14,700 Q_L}{d \times V_{us}} \quad (9)$$

where K is viscosity index; Q_L is flow, gpm.; d is valve size assuming nonviscous conditions, in.; V_s is viscosity, stokes and V_{us} is viscosity, saybolt seconds universal. Once the viscosity index is established, find the viscosity correction factor from Fig. 1.

For example: a valve is calculated for 60 gpm., 25 psi. pressure drop and a specific gravity of 1.25. Substitute these values in Eq. (4) to find the C_v factor. For this valve, the C_v factor equals 13.4 which corresponds to a valve size of 1.25 in. Suppose the liquid has a viscosity of 55 stokes. From Eq. (8), we calculate the viscosity index K which is equal to 27.6. The corresponding correction factor read from Fig. 1 is 1.65. Hence, corrected valve size is 1.65×1.25 or 2.06 in. A 2-in. valve is probably the best choice for these conditions.

Pressure Drop Across Valves

Pipelines, hand valves and other elements absorb energy from the fluid which passes through the control valve. The magnitude of the resulting pressure loss or pressure drop is a function of the flow rate. Hence, as the control valve increases or decreases the flow, pressure drop across the valve changes. This change affects Eqs. (1) through (7) because the pressure drop is no longer constant.

Since the pressure drop through the line increases with flow, pressure drop available across the valve must decrease. This effect reduces flow through the valve at higher flow rates. Fig. 2 illustrates this condition. Valve characteristic, without consideration of line losses, is also shown. As the line drop increases, maximum flow passing through the valve gradually diminishes and the flow characteristic is correspondingly modified.

Where only a small percentage of

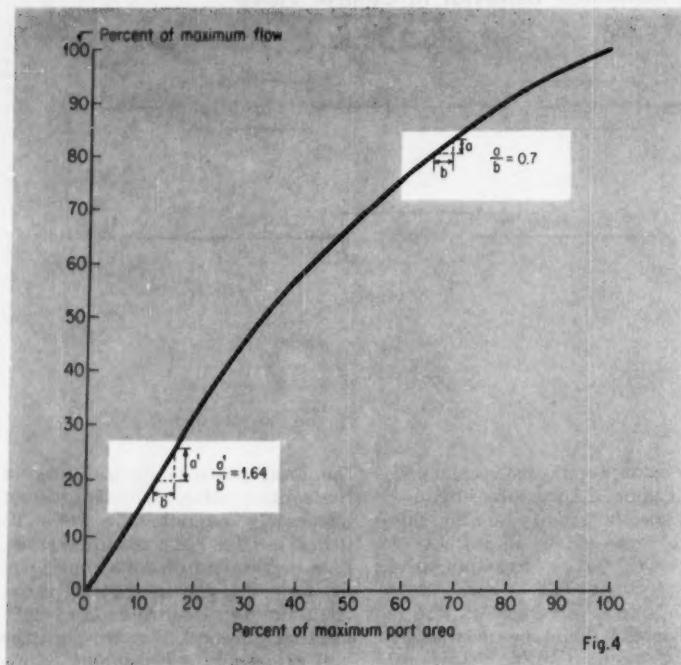
the total pressure drop occurs in the control valve, the valve cannot adequately regulate the flow. To utilize a valve for control purposes, it is necessary to have a considerable drop through the control valve. A minimum pressure drop of 20% of total pressure drop through the valve is generally acceptable. However, a valve drop of 30% or more is definitely preferred.

One method which improves the pressure drop proportion is to connect a pressure regulator in series with the control valve. In this case, pressure drops occurring beyond the regulator need not be considered.

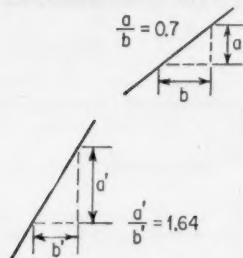
How to Size Control Valves

By considering valve characteristics as well as valve size, the following method shows how to select the correct valve. Fig. 3 shows the loop of a temperature control system. Magnitude of the controlled variable is not shown as being converted into a pressure or other signal. Therefore, input signal for the controller changes by one degree per degree temperature change. Gain or proportional band of the controller is such that its output changes by 2 psi./°F. Valve actuator converts this signal into stem motion and its gain is 0.1 in. stem motion/psi. signal change. Similarly, the plug changes the port area at the rate of 0.5 sq. in./in. of stem motion. This change in port area results in a gain in the piping of 200 gpm./sq. in. change in port area. Process gain is 0.5 °F./gpm. of flow rate change.

Change in Flow Rate Affects System Response



Slope Measures "Gain"



Flow Relations for Problem—Table I

Flow, Bbl./Hr.	Port Area, Sq. In.	Percent Maximum Port Area	Percent Maximum Flow
40	0.1	6	9
120	0.3	17	27
200	0.5	29	45
300	0.9	52	67
400	1.4	80	90
445	1.75	100	100

Total gain can then be expressed by

$$\frac{1}{F} \times \frac{2 \text{ psi}}{\text{F}} \times \frac{0.1 \text{ in.}}{\text{psi}} \times \frac{0.5 \text{ sq. in.}}{\text{in.}} \times \frac{200 \text{ gpm}}{\text{sq. in.}} \times \frac{0.5 \text{ F}}{\text{gpm}} = 10 \quad (10)$$

In the ideal case, this gain would be maintained for any set point, pressure drop or load condition. However, the gain is not constant and changes—particularly in the piping and in the process. Purpose of the characterized valve is to compensate, at least partially, for these changes in gain or nonlinearities.

It is an essential function of a valve to produce a pressure drop. But there is more than one pressure drop that must be considered in connection with control valves. Pressure drop in the valve body consists of the drop across the inner port and the drop caused by turbulence in the valve body. There is also the pressure drop in the pipeline.

Pressure drop in the valve body is an expression for quality of design. It is desirable to have this drop as small as possible to reduce its effect on the C_v factor. If the pressure drop in the valve body in-

creases at higher flows, then the C_v factor contains an error source. Since it is physically impossible to measure the pressure directly before and after the inner port, pressure is measured in the inlet and outlet pipes adjacent to the valve body. This pressure drop determines the C_v factor. Its magnitude is based on a pressure drop of 1 psi.

If this same valve is used for a 100-psi. pressure drop, pressure drop in the body increases because of increased flow. Then the flow is less than can be expected from the data of C_v factor and pressure drop across the valve. This is a limitation of the C_v factor. It does not inform about the efficiency in the design of the valve body.

In the following discussion, pressure drop in the valve body is neglected. Pressure drops in the pipeline and across the valve are the only ones under discussion. Consider a total available system pressure A_2 and a pressure loss in the pipeline A_3 . Then pressure drop across the valve A_1 is given by

$$A_1 = A_2 - A_3 \quad (11)$$

Pressure drop ($P_1 - P_2$) in Eqs. (5), (6) and (7) can thus be re-

placed by A_1 of Eq. (11). For example: Eq. (5) becomes

$$Q_L = C_v (A_1/G)^{0.5} \quad (12)$$

If the flow increases, the pressure loss in the pipeline A_3 increases and diminishes A_1 in accordance with Eq. (11). This change affects the linearity. Hence, the smaller the pipe loss A_3 , can be made in proportion to the system pressure A_2 , the more linear will be the operation.

Pipe loss is generally calculated by Fanning's equation which in a practical version is:

$$A_3 = 0.0066 GL/Q^2/D^4 \quad (13)$$

where A_3 is pipe loss, psi.; G is specific gravity; L is pipe length, ft.; D is pipe diameter, in.; f is friction factor and Q is flow rate, bbl./hr. The dimension, barrels per hour, has been chosen as one quite familiar in oil flow. Friction factors can be obtained from handbooks.

The following example shows how to calculate rate of flow for various port areas. Crude oil of 0.9 specific gravity is pumped through 120 ft. of 2-in. wrought iron pipe. Normal maximum pumping rate is 400 bbl./hr. Total pressure available is 250 psi.

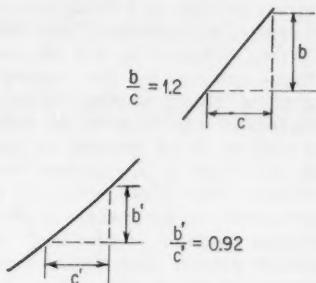
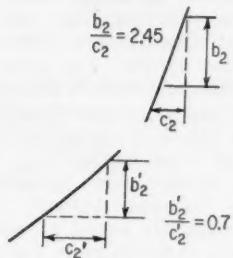
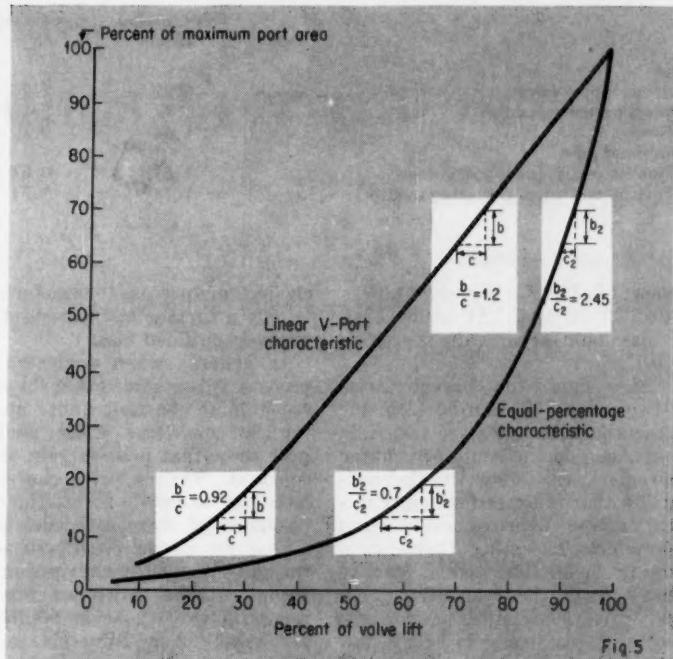
Change in Gain for V-Port**... Equal-Percentage Valve****For Problem: Match Valve and Pipeline Characteristics**

Fig. 5

The first step in the solution consists in determining the pipeline pressure drop at various pumping rates. At the maximum rate, the friction factor is 0.033. Inserting values in Eq. (13) gives A_s equal to 118 psi. Similarly for a flow rate of 200 bbl./hr., friction factor is 0.041 and A_s equals 36 psi.

Applying the same calculations to several additional values, gives the following table:

Flow, Bbl./Hr.	Pipe Loss, Psi.
40	2
120	15
200	36
300	65
400	118

A valve size is now chosen. For this purpose the maximum flow of 400 bbl./hr. is converted to 280 gpm. Pipe loss at this flow is 118 psi. Hence, pressure drop across the valve is $(250 - 118)$ or 132 psi. Use Eq. (5) to size the valve. Substituting the corresponding values gives $280 = C_v(132/0.9)^{0.5}$. Hence, flow coefficient C_v equals 23.

It is desirable to choose a valve so that it is about 80% open at maximum flow. Since many assumptions are generally required in

these calculations, 80% of maximum opening serves as a safety factor. Hence, the valve may actually have a C_v factor of 30. If this value can be obtained from a 1.5-in. valve, choose this valve size.

Next, it is necessary to obtain data on the relation of port area for various valve openings to the flow passing through these ports. Pressure drop in the pipeline must be considered. For a 1.5-in. valve, the port area is approximately 1.75 sq. in. To handle maximum flow of 400 bbl./hr., port area, corresponding to 80% of maximum opening, is 1.4 sq. in.

It is more convenient for this case to express flow in bbl./hr. instead of gpm. Hence, the constant k is chosen to include this conversion. Inserting values in Eq. (1) and solving gives $k = 23.5$.

Available pressure drop at 200 bbl./hr. is $(250 - 36)$ or 214 psi. Using Eq. (1) corresponding valve port area is 0.5 sq. in. Valve port areas can thus be established for all flow rates.

Also, it is possible to determine flow at maximum port opening. In sizing the valve, it was assumed

that the valve handles a flow of 400 bbl./hr. at 80% of maximum opening. Port area for this flow is 1.4 sq. in. Find the flow and pipe loss for the fully open valve which is equivalent to 1.75 sq. in. port area. A few trial-and-error calculations lead to an acceptable solution.

For example: assume flow under these conditions is 445 bbl./hr. Substituting this value and other quantities into Eq. (1) gives

$$445 = 23.5 \times 1.75 [(P_1 - P_2)/0.9]^{0.5}$$

Hence, pressure drop equals 105 psi. Pipe loss then equals $250 - 105$ or 145 psi. Friction factor for these flow conditions is 0.032. Use Eq. (13) to check whether or not these assumptions are acceptable. Result from the data gives $A_s = 142$ psi. which corresponds closely with the assumed loss of 145 psi.

Repeating the calculations for several flow rates yields the results shown in Table I. The gain or change in flow rate with change in port area at any point can be determined easily as shown in Fig. 4. At about 15% of maximum port area, the gain is 1.64. Here, flow increases 5.48% for a port area in-

System Gains for Sample Problem—Table II

Gain	Port Opening 15%	Port Opening 68%
Linear V-port valve	0.92	1.20
Equal percentage valve	0.72	2.45
Pipeline	1.64	0.70
Combined gain		
Pipeline and linear V-port valve	1.51	0.84
Pipeline and equal percentage valve	1.14	1.71

crease of 3.33%. Hence, gain is $5.48/3.33$ or 1.64. At about 68% of maximum area, gain decreases to 0.7.

Fig. 5 shows the characteristics of two valves. As can be seen, the linear characteristics are not fully linear, nor do the equal-percentage characteristics follow the theoretical function in exact fashion. Practical valves approximate certain characteristics rather than representing them. The task is now to choose from the two curves, the best valve characteristic for the process gains shown in Fig. 4.

The horizontal scale in Fig. 4 corresponds with the vertical scale in Fig. 5. Both show the percent of maximum port area. Gains which were shown in Fig. 4 for certain port areas are shown in Fig. 5 for the same port areas. It remains to correlate these data to obtain the combined gain for control valve and pipeline. The combined gain is obtained by multiplying the gains of the control valve and pipeline as shown in Table II.

It is now possible to determine which combination has the least change in gain. The object is to find the valve characteristic which best compensates for changes of gain in the pipeline. From Table II, it appears that the equal percentage characteristic would give somewhat better results since its gain changes by the ratio 1.71/1.14 or 1.5. The linear V-port characteristic changes the combined gain by the ratio 1.51/0.84 or 1.8.

However, this choice would be a somewhat hasty judgment. In the first place, the difference is smaller than the uncertainties which are inherent in such calculations. In the second place, comparison would be necessary between more than two points of valve port opening.

Evaluation of gain changes in the process will further influence the choice of valve characteristic. In-

clusion of process characteristics is only a further application of the methods outlined here.

In general, when analyzing the process, it is assumed that the process gain is constant under changing load conditions. Closer analysis may show that process gain is not constant. Then a valve characteristic may be chosen for partial compensation of these gain variations.

Changes of set point will affect the gain of almost any process. A tuning of the controller for one set point may cause instability or excessively slow corrective action at another set point. It becomes difficult, if not impossible, to consider all the effects and their combinations in selecting a suitable valve characteristic.

However, it is always useful to consider certain possible combinations such as valve characteristic, flow through the valve, load and set point, and to determine the gain under these conditions. Even if the nonlinearities cannot be satisfactorily eliminated by valve characterization, conditions which have the highest gain may, at least, be determined beforehand.

The preceding calculations show how nonlinearities may be reduced. Then, how is it possible to obtain satisfactory control under conditions where disturbing nonlinearities occur? To answer this question, we must consider static and dynamic conditions separately.

The static implication is that it is difficult to predict the position of the control valve. But what does this mean? The signal of a pneumatic controller, when the controlled variable is at the set point, is expected to be 9 psi. This signal should coincide with the mid-position of the control valve. Whether or not this midposition suffices to supply adequate flow to the process depends entirely on load conditions.

In a proportional-position controller, the valve will move in either direction in case of a deviation of the controlled variable from the set point. Whether or not the resulting motion is the correct amount is, again, anyone's guess. Nonlinearity has little to do with this motion. It all depends on the load, and offset is in this case unavoidable. This offset, which is a direct result of load changes in proportional position controllers, is generally greater than similar consequences of the nonlinearities. In floating controllers and those that include reset action, these deviations are automatically corrected by the controller action.

Therefore, in either case, considerable nonlinearities can be tolerated without having effect on the control system. The larger the gain of the controller, which means the narrower the proportional band, the less will be the error caused by either offset or nonlinearity. This occurs because the proportional band is the space through which the controlled variable has to change in order to move the valve through its full stroke. For example: if the proportional band is 20° F., an offset of 10% is equivalent to an error of 2° F. If the proportional band is 10° F., the same 10% offset results in only 1° F. of error.

Where the time constant of the valve is large compared to the process, the gain or proportional band in the controller is limited by the time constant of the valve. Therefore, as the time constant of the control valve becomes negligible as compared with that of the process, the gain of the controller can be increased. Hence, the effects of offset as well as nonlinearities become smaller.

Dynamically, nonlinearities require adjustment of the controller to assure stability under the conditions of highest gain. In practical operation, controllers are usually adjusted with enough stability margin to assure stable operation even when conditions are occasionally much closer to instability than originally expected. Here the nonlinearities may occasionally cause trouble. Since the controller is adjusted for specific load conditions or a certain set point, changes in either may produce instability and, thereby, require changes in controller adjustments.

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H. LESLIE BULLOCK, Consulting Engineer, New York, N. Y.

UNTIL a few years ago, most solid-solid and solid-gas interactions were confined to the metallurgical and ceramic fields—interactions, such as those found in blast furnaces, that were completed from raw material to product in one operation. Gravity separation of slag was not complicated; some unwanted substances could be burned out and released as gaseous products. Although important, base materials concentration was not too critical. Movement, even in heavy molten metals, produced a uniform, pure product.

Commercial development of such "new" metals as titanium, beryllium and zirconium has called for combination of sintering and extraction—an overlap of metallurgical and chemical engineering techniques. Uniform quality, high concentration and close ingredient contact are imperative for electronic and magnetic compounds. With little motion in sintered solids, intimate contact and gas diffusion through the mass of solids must accomplish the desired change. In short, new products require increased attention to details of solids preparation.

Preliminary Steps

Two cases demand careful attention: solids preparation for reactions to produce a refined product of precise chemical analysis, and preparation for formed objects of particular electronic or magnetic characteristics. Preliminary physical beneficiation, through use of a combination of screens, tables, flotation cells and air, magnetic and electrostatic separators, is almost always necessary. Often the desired concentration and purity of a mix ingredient can be obtained only by preliminary sintering, chemical treatment or electrical deposition.

Intimate, uniform mixes may be required for pressing or extrusion of solids into objects with special characteristics such as resistors or ferrite cores. In some cases, thorough mixing goes back to the preparation of the powder mix before sintering to produce correct crystal structure. Growth of the required crystal form must be achieved from loose powder, with carefully controlled conditions of environment.

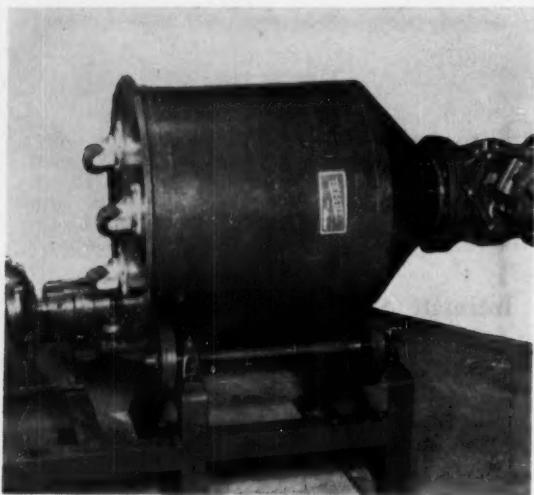
Coarse grain structures of some cast materials and oriented crystal structure produced by rolling or forging detract from uniformity. In a nuclear reactor, this might lead to radiation damage of the formed parts. However, careful preparation of metal powder particles permits manufacture of randomly oriented, pressed and sintered structures such as beryllium reflecting and absorbing pads that are resistant to radiation damage. Uniform, intimate mixtures of nuclear fuel materials permit formation of fuel elements having long life and uniform radiation response.

Successful preparation of solids includes proper base materials selection. In dry solids interaction, the type of crystal is often important and may be the controlling factor. Method of production may be critical: differences have been found between materials produced by chemical precipitation and by calcination, although the chemical analyses were identical.

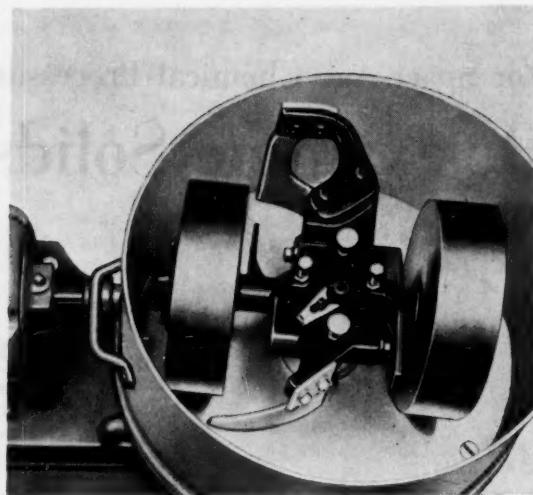
Some materials seem to require a definite history of formation. Doan has observed that in producing magnetic oxides, the magnetic properties are more pronounced if the material has passed through the Fe_3O_4 phase.* There are instances of hydrated oxides being more magnetic than other oxides.^{*}

Usually there is a narrow range of particle size in which optimum results may be obtained. Where gas diffusion produces the chemical change upon calcination of dry solids, large particles require longer treatment. In ceramic products, large particles may produce a visible grain structure or a weakened structure; strength is limited to that of a single ingredient rather than to that of the fused mass. Particles of extremely small size, however, are usually more costly, especially if produced by grinding. Their apparent densities are low. The fluffy structure of fine powders contains a high percentage of voids. Oxygen addition from these voids is often a serious contaminant.

Surface preparation is often required to avoid contamination with adsorbed gas or to remove oxide coatings. Then intimate contact will be assured either for interaction or for cementing the particles. It's best, in the case of sensitive substances, to avoid oxide coating by vacuum or inert atmosphere preparation.

**For Safety . . .**

Tumbler mixer and container. Choose this mixer when solids must be protected against outside contamination or when they are highly toxic. Material remains inside container throughout preparation. (*Fey Steel*)

**For Tough Aggregates . . .**

Muller wheels and plows. Use a muller when tough aggregates require crushing and particle size or concentration are so great that it's advisable to coat one ingredient with another. (*National Engineering*)

Whether the material is prepared in contact with an inert gas or with air, gas in the voids and adsorbed gas should be removed if intimate, dense mixing is desired. This may be done by mixing under vacuum, or the gas can be displaced by means of a low-boiling liquid which can evaporate in the mixer. A quicker, more complete displacement of adsorbed gas results if a slurry, made up with the low boiling point liquid, is passed through a colloid mill arranged for escape of the gas. Passage through a colloid mill breaks down the aggregates and exposes the total particle surface to the displacement action of the fluid. The proper fluid and mill will produce a heavy paste, rapidly separable into a fluid-covered cake of solid material that can be decanted. Since the cake is nearly free of voids, the amount of liquid to be evaporated is small.

Mechanical scouring, chemical washing, or a combination of the two, is often needed just before mixing. Preliminary dry densification, such as is done in preparing commercial zinc oxide for ceramic use, may also be done either by pelletizing or by pressing under light vacuum.

Select Proper Blending

Although continuous mixers are desirable, accuracy of proportional solids feeders, variations in rates of material flow, possibility of dead spots and restrictions on mass blending limit their use. Only an extensive test can tell you if a continuous mixer will give the necessary uniformity required by your operations. If continuous mixing is used, it's good insurance to provide an oversized unit, with recirculation of a large portion of the discharge.

Whether continuous or batch mixers are chosen, design should eliminate dead spots where portions of the mix will lie dormant and produce differences in the formulation. Mass uniform blending of the various ingredients before intensive mixing action produces the intimate materials contact necessary in the final product.¹

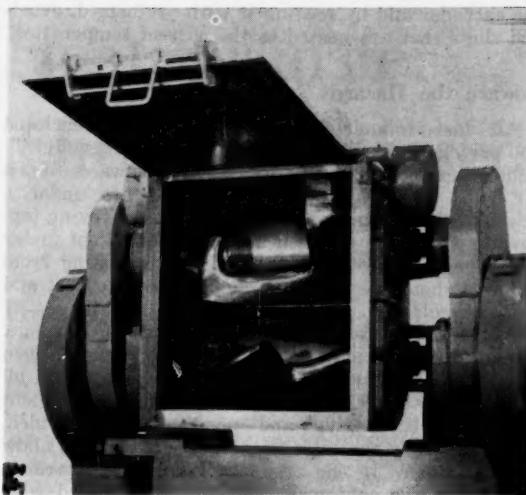
Selection of the mixer will depend upon ingredients of the mix, allowable variations in uniformity and the next step in production.

If ingredients of a mix have approximately the same particle size and density and do not contain aggregates which must be broken down to ultimate particle size before mixing, rotary mixers of the tumbler-, lift-vane- or conical-blended-type can be used.

If the materials must be protected against outside contamination or are highly toxic, a tumbler mixer can be used. After filling, this self-contained, caster-mounted unit is sealed with a rotary flanged valve. It's then transferred to the tumbler frame and rotated for the required mixing time. The package unit is finally inverted over the inlet of the next processing unit and bolted into place. Upon opening the valve, the mixed material flows into the processing unit.

Where fairly soft aggregates must be broken down and great differences in particle size or gravity exist, the materials might segregate in tumbler mixers. For this case, ribbon mixers fitted with paddles and breaker bars set at close clearances can be used.

If tough aggregates require crushing, and if the differences in particle size or concentration are so great that it's advisable to coat one ingredient with another, a muller-type mixer is indicated. Muller-type mixers, through their wiping and positive crushing



For Kneading . . .

Sigma-blade mixer. Select this kneader to handle suspensions, pastes and light plastic masses. Sigma blade is for general-purpose kneading, but blade edges may be serrated for shredding. (*Baker Perkin*)

action, produce an intimate contact that tends to avoid segregation. Even in the absence of a binder, the materials will stand rough handling.

When a sticky binder is part of the formulation so that the mix is tenacious enough to be acted upon by shearing forces, sigma blade mixers often produce excellent results. This mixer can also be used, as the Banbury mixer on rubber and plastics, where one of the ingredients is softened enough by heat and pressure to smear over the other ingredients and act as a binder. The product of these mixers is very stable.

These mixers produce uniform blends of certain ingredients, but selection is also influenced by the desired permanency of the blend. In the absence of a binder, materials coming from tumblers and ribbon mixers can segregate at the point of discharge, in the transporting container or upon delivery to the next operation. Great care must be used to avoid this action.

Densification is desired in the majority of dry mixing operations. Since little densification results in tumbler-type mixers, the mixed material is often fed to a roll mill for densification by formation of thin plates. Some tumbler mixers can be used as rotary pelletizers by the addition of small amounts of liquid after dry blending. This can result in a densification of up to 30% reduction in volume. Pellets also can be formed by forcing damp or tacky material through a perforated die and cutting it off to proper length with a moving knife. Final density of these pellets depends on size and length of the holes in the plate and packing qualities of the mix.

In muller-type mixers, dry powders can be densified to about 20% reduction in volume. Where one in-

gredient is coated with another or where a liquid is added, very dense products are possible. In the sigma-blade mixer, the pressure which might produce increased density is the result of shear resistance. Therefore, densification is low in these mixers unless a binder is present. In Banbury-type mixers additional densification is produced by means of a moving internal cover which is forced down on the load by air or hydraulic pressure.

Practically any type of mixer can be arranged to work under vacuum or controlled atmosphere. Vacuum operation is used to remove adsorbed gases, to allow evaporation of liquids at low temperatures and to avoid oxidation of the extended surface of the mix. Controlled atmosphere is used not only to protect the materials against oxidation, but also to provide heating or cooling of the charge.

Formation and Furnaces

After mixing, the next step in preparation is usually one of formation—either for subsequent sintering and extraction or for end-use objects of proper shape and size.

Loose powders can be fed into baking, sintering and roasting ovens, but reduction of dust losses and economy of space in most cases favors densification into pellets, flakes, briquettes or blocks. Pellets can be formed by rolling the mass of material in a cylinder. They can also be shaped in press molds or in cavities in mating rolls. Pellets formed by rolling the material in a barrel are spherical or egg-shaped, with considerable shape and size variation. Smooth rolls can be used to produce flakes of irregular shape and size.

Although "briquette" denotes a small brick, for three good reasons most briquettes are egg- or pillow-shaped. First, molds of this shape are easy to fill, and they discharge the briquette cleanly. Second, they can be proportioned so that heating is uniform throughout the mass. Third, sharp and fragile edges and corners are avoided. Briquettes are really large pellets, but their larger size calls for greater strength and density than can be obtained by barrel rolling. They are either ram-pressed or formed in rotary molds.

Block sections, whether of rectangular brick or cylindrical form, are usually formed by continuous extrusion. The rods are cut into uniform lengths as they emerge from the extrusion die. Rectangular blocks have sharp edges and corners that are subject to breakage. Another disadvantage is that flat faces can line up in close parallel contact, masking each other in a furnace. This is especially bad where the reaction depends on furnace atmosphere. However, if all the ingredients for the furnace reaction are contained in the blocks, and if comparatively slow heating over a long period is not injurious, the low-cost, extruded rectangular blocks can be used to good advantage.

Cylindrical blocks cannot mask each other except by end-to-end contact and by line contact of curved surfaces. The masked portion can be only a small part of the total surface area. Line contact of the cylinder edges may interfere with circulation of the furnace gases, but random feeding can offset this condition.

When feeding into batch or continuous retorts, careful study must be made of packing conditions, breakage and disintegration. Uniform packing is necessary

SOLIDS PREPARATION . . .

to produce uniform results. Breakage can produce great differences in point-to-point batch density. Disintegration upon heating can alter relative surface exposure to drop yields below the economic recovery point.

Where briquettes are fed onto a moving hearth, care must be used to insure uniform depth and surface pattern loading. Heat input into an oven or furnace is usually on a uniform, over-all basis with regulation dependent upon temperature at one or more control points. In many sintering operations, the heat and temperature range is very narrow. Low temperatures and too little heat may produce products not subject to extraction. Just the right temperature and heat will produce high extraction, while too-high temperatures and too much heat may produce extractable products of undesirable materials. This condition is well-illustrated in the sintering of beryllium ore where the time and temperature range is extremely narrow.⁴

Uneven feed to the hearth can produce starved areas where, as the charge passes through the furnace, the local temperature rises until product damage results. Crowded areas can also be produced where the additional mass keeps the temperature below that necessary for a high yield of extractable material.

Products in which application performance depends on crystal structure and on traces of elements are usually extremely sensitive to kiln environment. Huettig, in speaking of ferrites, reports that "a firing shrinkage variation of 1% can cause a performance variation of 50% or more," and "so sensitive are the magnetic properties of the ferrites that final performance can be varied 50% or more by the choice of the setting surface."⁵

One last word on formation: Striations, whether caused by undispersed aggregates of a single material or by slippage of the charge due to faulty press cylinder and nozzle design, must be avoided. Good mixing will take care of the first cause. Striations caused by mass slippage usually result from using an extruder tube of large diameter with a small-diameter nozzle. If a screw extruder is used, do not try for too great reduction at the nozzle. If using a ram extruder, keep the diameter of the extruder close to that of the nozzle; increase capacity by lengthening the bore of

the extruder and by feeding it with preformed, densified slugs that are heated to the correct temperature.

Beware the Hazards

All dust-producing equipment should be enclosed and preferably should be operated at pressures slightly under atmospheric so that leaks will be inward. When air must be excluded and operations are under a selected pressurized gas, mixing and conveying apparatus should be enclosed in small rooms kept under slight negative pressure. All air or gas coming from the area should be passed through a suitable dust and fume collector.

Avoid concentrations within the explosive range. If the explosive range must be passed through, even if only at the start and finish of the cycle, avoid all chances of static electricity formation. All equipment should be thoroughly and permanently grounded. Check carefully for high-temperature spots, and allow no open flames in the area. In extremely hazardous operations, the equipment should be scavenged with inert gas during startup and shutdown. Do not let dust collect at any point; it might be forcibly disturbed and form an explosive mixture with the surrounding air.

Mixing of incendiary, pyrotechnic and rocket powders demands special precautions. Remember that motive power applied to the mixer eventually shows up as heat. With all sensitive materials, provide for removing this heat by air- or jacket-cooling or by evaporation from the mix. With some very sensitive materials, it may be necessary to cut down on power input, either by reducing speed or the number of mixing elements or their contact area.⁶ It may be necessary to use specially designed equipment in which crushing or pinching of material is avoided and in which sliding friction in thin sections under pressure is impossible.

If exothermic chemical reaction occurs in the mix, ample provision must be made to remove the heat as it is generated, just as in the case of frictional heat. Some sensitive materials are delivered directly from mixer to forming molds, and the binder is introduced into the mix as a monomer which catalytically polymerizes in the mold. Contact of catalyst with monomer produces an exothermic reaction. If the monomer and catalyst are added separately to the powders in the mixer, it may cause a local catalyst concentration, producing a dangerous temperature rise. Instead, always thoroughly mix the catalyst in the monomer in a separate vessel and slowly add the mixed liquid to the powder in the moving mixer. Avoid adding slugs of liquid so that there's no chance of local overheating.

Never undervalue the importance of chemical solids preparation. Combination of careful formulation and proper material selection, thorough blending, careful handling, and consideration of the physical characteristics of the blended material as it goes to the next processing step helps insure product success.

Meet Your Author



H. LESLIE BULLOCK is a licensed professional engineer (New York) engaged in private consulting practice. Educated in mechanical engineering at Columbia University, Bullock has wide experience in the

processing industries, especially in aspects of solids operations. He has written many articles, for Chemical Engineering and other technical papers, and lectured at Columbia University and M.I.T. He is a member of ASME, SPI, American Ordinance Assoc. and National Panel of Arbitrators.

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Heat Transfer Through Glassed Steel

True, glassed steel has a low conductance,
but don't let this stop you from
selecting it as a construction material
for service with viscous, corrosive or dirty fluids.

Glass Steel

EDWARD J. ACKLEY, The Pfaudler Co., Rochester, N. Y.

GLASSED steel is often selected as a barrier material between media during heat transfer processes because of its demonstrated resistance to corrosion and fouling. However, engineers sometimes feel that they are making a substantial sacrifice in heat transfer efficiency when they select glassed steel. Such is not always the case.

This article will demonstrate that under many process conditions, over-all coefficients of heat transfer for glassed steel are comparable with those of materials having much higher thermal conductivities.

Conductance Not Sole Factor

In the specific case of glassed steel, the total barrier resistance to heat transfer is the sum of the combined resistance characteristics of the fused glass and steel.

Photomicrographs of a section through a glassed-steel plate (see photo above) show a true chemical and physical bond at the irregular interface. No additional resistance exists at this interface.

Table I compares the conductance (reciprocal resistance) of glassed steel with that of four other barrier materials commonly used in the construction of heat transfer equipment. Wall thicknesses shown are those normally used at ordinary pressures.

In Table I, note that impervious graphite shows the highest conductance, and glassed steel the lowest, of the five materials selected.

Conductance, however, is not the sole factor controlling the efficiencies of heat transfer processes. Film and fouling resistances as well as the barrier-wall resistance take a part in determining the over-all coefficients of heat transfer.

E. J. ACKLEY, now a group leader in Pfaudler's applications engineering department, received his BS, ChE from the University of Rochester in 1953. Prior to his present association with Pfaudler, he worked as a thermal design engineer with Alco Products.

Film Resistances May Control

Conventional methods such as the Sieder & Tate² and Nusselt³ equations are useful for calculating film resistances for liquids and condensing vapors in glassed-steel pipe. Film resistances for liquids in a glassed-steel reactor are given by the equation⁴:

$$h = \frac{0.33 k}{D} \left(\frac{L^2 N_p}{\mu} \right)^{2/3} \left(\frac{C \mu}{k} \right)^{1/3} \left(\frac{\mu}{\mu_w} \right)^{-0.14}$$

Table II lists actual over-all service coefficients for four typical heat transfer operations. For this table, all equipment was considered to have been in use for some time; fouling resistances assumed are those normally used for these processes, and can be found in McAdams.¹ The term $h_s + h_f$ in the table is, for each case, the rule-of-thumb coefficient commonly employed in the design of industrial equipment.

Table II indicates that heat transfer through the selected barrier materials is markedly affected by the film resistances of the media being processed. When the sum of film coefficients is high, as is usually the case for condensation of a saturated vapor in the absence of a noncondensable gas, then the choice of barrier will materially influence the service coefficient attained in the actual process. The conductance of the barrier wall, in a sense, "controls" the over-all coefficient.

On the other hand, for those heat transfer services in which film coefficients are quite low, as in cooling a viscous organic liquid, the influence of the barrier material is negligible. In these instances, the film coefficients control the over-all coefficient.

Percentages Clear Picture

The importance of the kind of heat transfer service as it influences service coefficient is made clearer by the percentage figures in Table II. Here, each over-all coefficient is presented as a percentage of impervious graphite's coefficient for that service. For example,

GLASSED STEEL . . .

Conductances of Various Barrier Materials—Table I

	Specifications	Wall Thickness, <i>l</i>	Thermal Conductivity, <i>k</i>	Conductance, <i>k/l</i>
Stainless steel (heat exchanger)	16 BWG tubes Type 304 SS	0.063	105	1,670
Impervious graphite (heat exchanger)	3/16-in. tube wall	0.1875	975	5,200
Glass (heat exchanger)	0.0625-in. wall	0.0625	8	127
Stainless steel (reactor)*	21/32-in. wall Type 304 SS	0.656	105	160
Glassed steel (pipe or reactor)*	11/16-in. steel wall	0.05 (glass) 0.688 (steel)	6 360	98 (combined)

* Thickness based on 1,000-gal. reactors for service at same pressures.

Heat Transfer Coefficients for Four Typical Services—Table II

	Service Coefficients Btu./(Hr.) (Sq. Ft.) ($^{\circ}$ F.) and Percentages Referred to Graphite			
	Heating Water With Steam	Condensing Organic Vapor With Water	Cooling Organic Liquid With Water	Cooling Viscous Organic Liquid With Water
Stainless steel tube	184 (92.5%)	79 (96.5%)	43 (100%)	18.9 (100%)
Impervious graphite tube	199 (100%)	82 (100%)	43 (100%)	18.9 (100%)
Glass tube	89 (44.7%)	56 (68.3%)	36 (82.5%)	17.3 (91.6%)
Stainless steel reactor	83 (41.7%)	54 (65.2%)	35 (80.9%)	17.0 (89.9%)
Glassed-steel reactor, pipe	71 (35.7%)	48 (58.5%)	32 (73.8%)	16.3 (86.2%)
Film coefficients only, $h_i + h_o$	300	100	50	20

the table clearly shows almost a threefold variation in the various coefficients for a service involving the heating of water with steam.

Those services involving low film coefficients, as in heating or cooling viscous organic liquids, present a different picture. Table II indicates that for such service, the barrier with lowest conductance, glassed steel, still yields a coefficient 86% that of the material having maximum conductance.

This is quite fortunate because it is for services involving viscous materials, and those in which corrosion, contamination and ease of cleaning are of great importance, that glassed steel is most frequently used.

In heat transfer services involving chemical reactors, a choice is sometimes available between the use of stainless steel or glassed steel as the material

of construction. When making a decision for such cases, it is rarely justified to stress the higher conductance of stainless steel as an important factor.

This also can be seen in Table II. When cooling an organic liquid, the service coefficient for a glassed steel reactor is 91.3% that for a stainless steel reactor. If the liquid is viscous, the coefficients for the two materials are almost identical.

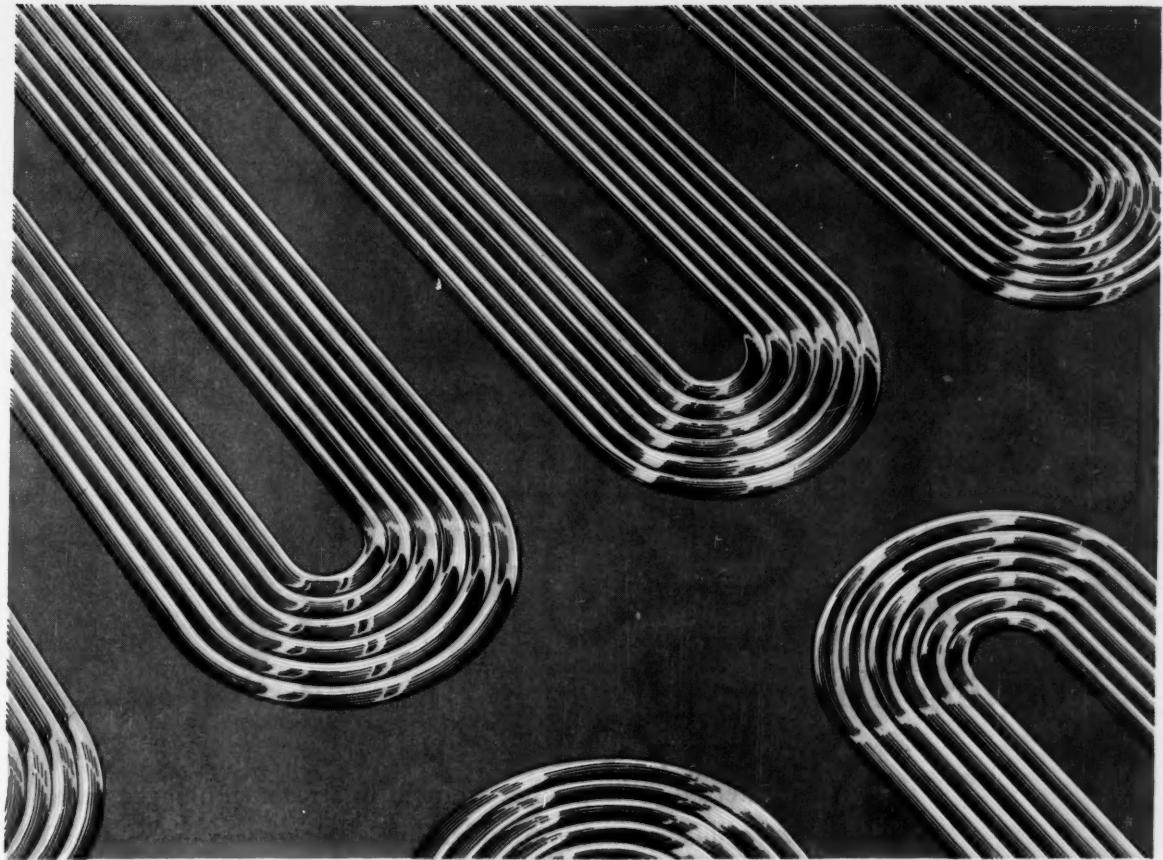
Other Factors to Consider

Service coefficients and the relative efficiency of the various barriers in Table II were computed without regard to product buildup or excessive scaling and corrosion. In actual processes, the usefulness of glassed steel may be further enhanced because of its marked resistance to fouling and corrosion.

Glassed-steel equipment presents a smooth, easy-to-clean surface to the product, thus minimizing adherence. The glass resists corrosion of all acids (except hydrofluoric) at elevated temperatures, and alkalis at moderate temperatures. These properties cannot be quantitatively evaluated or generalized, but experience shows that frequently they more than compensate for the slightly lower service coefficients calculated for glassed steel.

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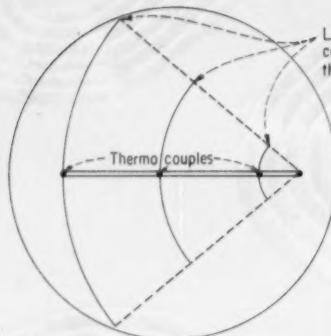


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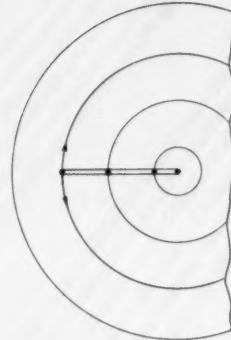
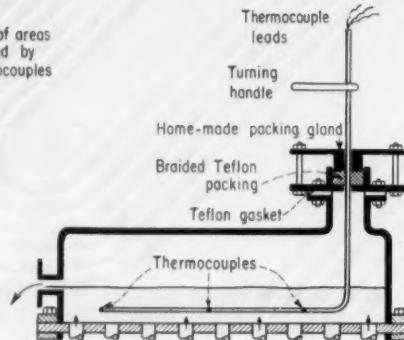
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PRACTICE . . .

PLANT NOTEBOOK EDITED BY T. R. OLIVE



Arrangement with side-mounted thermocouple



Alternate arrangement with central thermocouple

Rotating Thermowell Finds Plugged Tubes

When internal cooling tubes are used in a reactor, plugged tubes can cause hot spots—and trouble. Here's an easy way to find them.

Jerome Seiner

Development Engineer, Springdale Research Center, Paint Division, Pittsburgh Plate Glass Co., Springdale, Pa.

When using a heat exchanger as a chemical reactor, tube plugging can lead to hot spots and present a serious problem. For example, the internal heat exchange tubes may be used to cool an exothermic reaction. Then partial plugging can cause a runaway reaction in some tubes, possibly leading to an accident. At least, it can cause accelerated corrosion of the tubes and result in leakage between the process and the cooling fluids.

One method for checking on the uniformity of flow among the various tubes is to measure their outlet temperatures. This could be done by installing thermocouples at the outlet of each tube, but with a large number of tubes this would be expensive.

A much simpler approach is shown in the sketches above. The scheme shown here consists in fabricating a rotating thermowell and packing gland assembly which, with only three thermocouples, can still cover a large area of tube outlets quite satisfactorily.

If a center flange is available, even better coverage of the entire tube area can be secured, as at the right. The same type of packing gland can be used on the central opening.

In one particular application, where pyrophosphates were corroding a Hastelloy reactor, the

three temperatures were recorded on a strip chart. Once an hour the operator would rotate the thermowell. Then, if he noticed major temperature changes at any of the three recorded points, he could take corrective action before any major damage to the tubes could take place.

Next Issue: Better Way to Find Liquid Flow Patterns

By Merton Allen, Winner of the March Contest

★ How Readers Can Win

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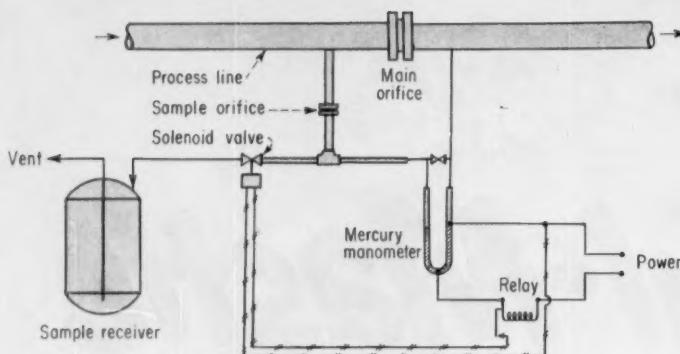
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Lewis Drehman

Research & Development Dept., Phillips Petroleum Co., Bartlesville, Okla.

It is frequently desirable to take a composite sample of a process stream over an extended period of time. If the stream varies in composition and flow rate, it becomes difficult to obtain a representative sample. However, there are various ways in which such a sample can be taken. The sketch above shows one such method for a gas.

The method involves using two orifices having a fixed flow relationship. The larger orifice, in the process line, may conveniently be a regular flow-measuring orifice. The smaller sample orifice, installed in a branch line, leads to a solenoid valve and then to a sample receiver. It also connects with the top of a mercury manometer whose other leg connects to the process line downstream of the main orifice.

Two electrodes in the manometer provide contact with the mercury and close a circuit through a relay. The upper contact is adjusted so as just to make contact when the mercury level is essentially equal in both manometer legs. Assuming no flow through the sample valve, the upstream pressure on the lefthand manometer leg moves the mercury upward in the righthand leg, making contact and (through the relay) opening the solenoid valve. Now, sample flows into the receiver, but this decreases the pressure downstream of the sample orifice and

breaks the mercury contact so as to close the sample valve. Pressure then builds up again and the cycle repeats.



Lock Prevents Opening of Quarter-Turn Valves

R. V. Butz and Richard Duty
*Monsanto Chemical Co.,
Texas City, Tex.*

A special locking device that has recently been developed at Monsanto Chemical Co.'s Texas City plant has solved the safety problem of insuring that a plug-cock type of shutoff valve cannot be opened during maintenance operations.

In the past, when maintenance work was going on, on lines carrying high-pressure, combustible or toxic fluids controlled by plug-

Both orifices operate on the same pressure differential and are independent of the total pressure, so the ratio of main and sample flows is fixed by the area ratios.

As shown in the sketch the hookup is suitable for sampling a gas stream. By simply reversing the connections on the sample receiver the instrument can be used for liquids.

Still another arrangement can be used if the process stream is at atmospheric pressure or below. In this case, the sample receiver is connected between the sample orifice and the solenoid valve. Then the valve will discharge into a reservoir which is maintained at a pressure below that of the process stream.

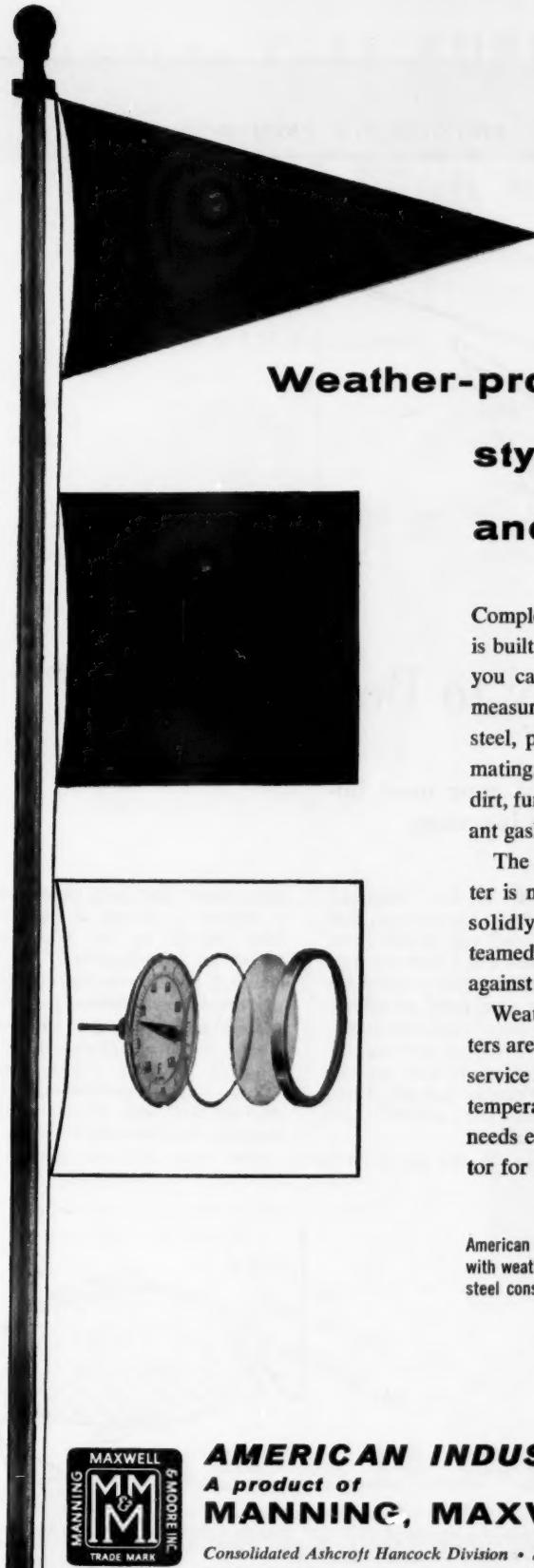
Instead of a mercury manometer, relay and solenoid valve, it is possible to substitute a suitable differential-pressure sensing device and transmitter, together with an air-operated sampling valve. However, the cost would be higher.

cock valves, we had no satisfactory method of safely locking out the supply without breaking out piping. Past usage called for a chain and lock around the valve handle, but slack in the chain allowed the valve to be partially opened.

Although the new device is being used at Monsanto primarily to lock out the starting air system on internal combustion engines, it has numerous other applications.

When maintenance is being performed on an engine, we can now use the new device to block the starting air supply positively, thus insuring that the engine cannot be accidentally turned on. To make assurance doubly sure, both maintenance and production personnel add a lock so that both parties must remove it.

The device is a U-shaped piece of steel with a cut-out for the valve stem. In use, it is slipped over the stem after the valve has been shut and the handle removed. Then the chain, which is welded to one end of the U, is carried around the back of the valve and locked to a ring welded to the other end.



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PRACTICE . . .

YOU & YOUR JOB

EDITED BY R. F. FREMED



Here's "A New Way to Better English"**

It's time to sharpen up one of your most important engineering tools: the English language.

What is good English? Try to find the answer to this question in any ordinary textbook and you'll be baffled and frustrated. Nobody seems to know what good English consists of.

"Writer's Guide and Index to English," by Perrin, for instance (now the most widely used college text), has 18 pages on the topic, studded with such sub-topics as "purpose of communication," "choice of level of usage" and "consistency in tone," and climaxing in a 102-word definition telling you in the end that good English usage is "appropriate to the writer himself."

Not much help, is it? Look into any other textbook and the result will be much the same. Good English is elusive, hard to define and a pearl of great price that only the chosen few will ever be able to grasp.

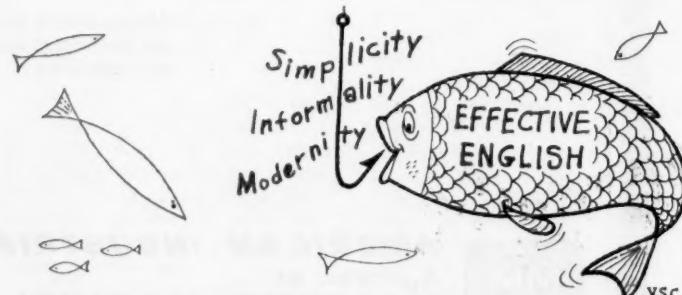
And yet, practically speaking, it's very simple. You know what good English is. Good English is the kind of English that people won't recognize as bad English.

And what is bad English? Why, everybody knows that. Bad English is *ain't* and *he don't* and *this here man* and *I seen him* and *February* without the *r* after the *b*. It's the sum total of all the mistakes your schoolteachers worked so hard at getting out of your system. If you use bad English, it means that you didn't learn what you should have learned in school.

Of course, in the olden days,

this meant that you never went to school at all—or at least not long enough to get what was known as "an education." If you couldn't spell properly or made grammatical mistakes, you were marked as belonging to the lower class. Good English—that is, English without obvious mistakes—was a tremendously important first step if you wanted to go up in the world.

But that isn't so any more.

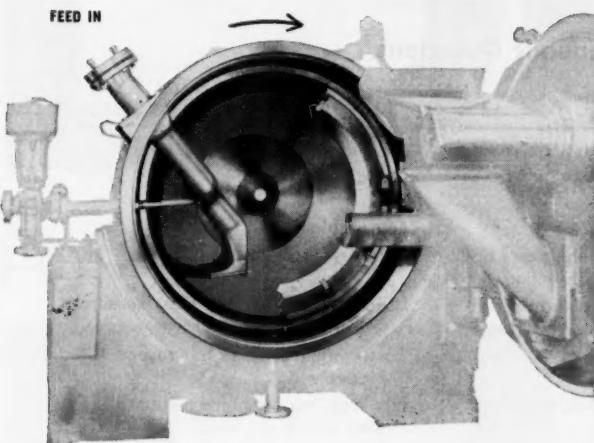


* This article is a shortened version of Chapter I from the book "A New Way to Better English," copyright 1958 by Rudolph Flesch and published by Harper & Brothers, New York. Permission granted.

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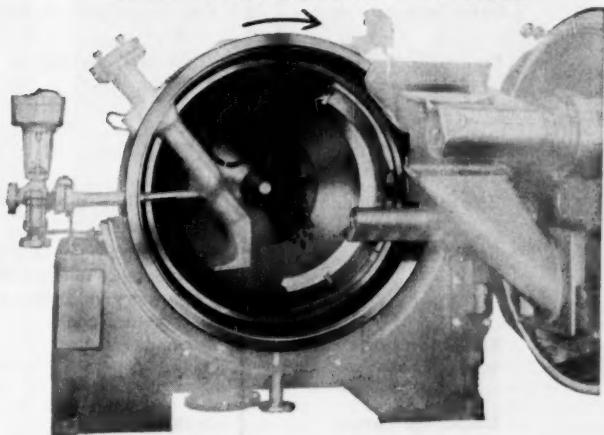
At this high speed the thin layer of crystals quickly gives up its moisture—thus even slow draining crystals may be handled at high capacity.

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With ample power available in the C-41, a thin cake of crystals is accelerated to rotational speeds up to 1250 rpm in 6 to 12 seconds—and is subjected to centrifugal force of 900 x gravity.

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Good English is still essential, but practically everybody nowadays *has* gone to school and practically everybody *does* avoid these obvious mistakes. Good English has become common and unimportant. If you feel a little weak in elementary English, you spend some time with a grammar or spelling book, and that'll

be that. But saying *he doesn't* and *I saw him* won't be of any particular help to you in climbing the ladder of success. Those days are gone.

Better Vs. Good

That's why I called this book "A New Way to Better English." I am not going to teach you

"good English" because I assume that you already know that. If you are the kind of person I imagine you are—someone with a high-school or college education who has a job with some organization—then it's extremely unlikely that you need a handbook on elementary English.

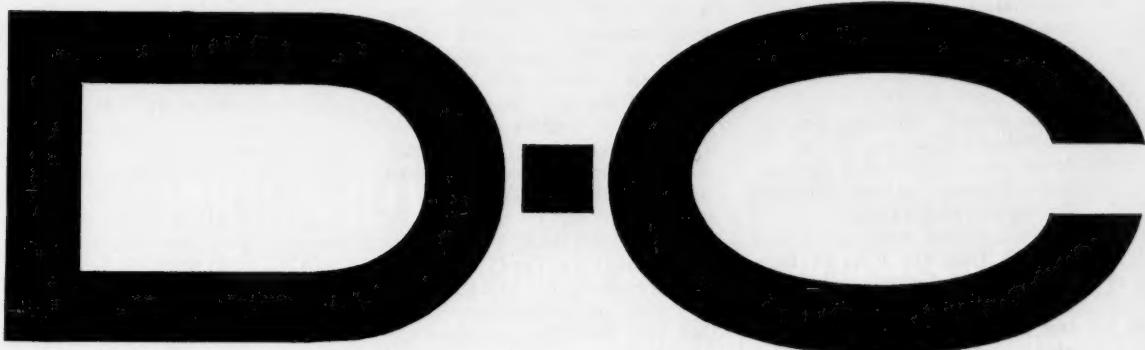
So, "this here book don't deal

Common Usage Has Settled These Academic Questions

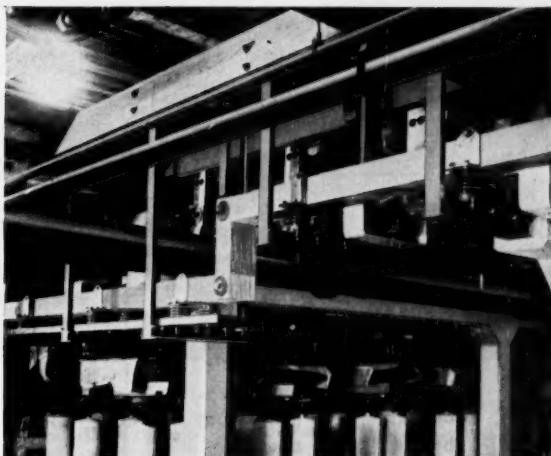
Questions	Perrin's Answer	Evans' Answer
Anyplace	Informal.	Acceptable. Good English.
Can used rather than may for permission.	Often used.	
Can't seem to	Informal.	Acceptable.
Data is singular vs. data are plural	Can be used safely in any but the most formal writing.	Perfectly good English.
Different than	More often used than different from in informal usage.	Used by some of the most sensitive writers of English.
Due to used as a preposition.	Increasingly common in print.	Used this way in very respectable places.
If used rather than whether	In informal English, whether is rarely used.	If never has been restricted in this way and is not now.
It's me.	Has full standing.	Natural, well-bred English.
Less rather than fewer.	General usage.	Standard English.
Loan used as a verb.	Properly a verb in American usage.	Thoroughly acceptable in the U. S.
Preposition at the end.	Generally the normal word order.	In English there are some constructions in which the preposition must precede the object and some in which it must follow. And there are others in which either word order is acceptable.
 	 	Used freely by the best modern writers.
The reason is because.	Frequently found in writing.	The rule against splitting an infinitive contradicts the principles of English grammar and the practice of our best writers.
Split infinitive.	There is no point rearranging a sentence to avoid splitting an infinitive, unless it is an awkward one.	Idiomatic and literary.
 	 	Standard English.
These kind of.	Informal.	Correct.
Try and used rather than try to.	General idiom.	Preferred.
Under the circumstances.	Standard.	Preferred.
Was used rather than were following if.	More usual in speaking and informal writing.	Acceptable.
Who used rather than whom. (Who do you want to see?)	Generally accepted in informal English.	In this country will is used as the future auxiliary in all types of sentences.
Whom used rather than who. (People whom I think are experts . . .)	Sometimes occurs.	
Will and would used rather than shall and should in the future tense.	The prevailing use in the U. S.	



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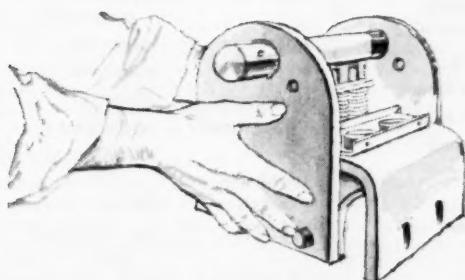


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with none of them ordinary mistakes."

Instead, it offers you "better" English. And this needs a bit of explanation. Perhaps you expect this book to give you discussions of certain fine points of usage, lists of rare words to add to your vocabulary, unusual constructions known only to English scholars, and so on. If so, I'll forewarn you just as I have always forewarned my students during the past 14 years.

Don't expect from me better English than the kind of English you are already used to; all I can give you is a way of making the best of the language you speak and write every day.

And now, having explained that the rest of this book is *not* going to deal with such matters, I'll devote most of this chapter to questions of usage and vocab-

ulary—simply to get them out of the way.

Let's begin once more by looking at the split infinitive, the question of "It's me" and the preposition at the end of a sentence. The most important thing to realize about these so-called disputed usages is that there is a well-known list of them, a catalog of one or two dozen items everyone has heard at one time or other.

It's just one of the facts of everyday life that people split infinitives and end sentences with prepositions, while English teachers try to stop them. This has been going on ever since any living person can remember, and that's that.

The People Have Won

Or rather, that *was* that—up until five or ten years ago. For

the astonishing fact is that today (I am writing in the Spring of 1958) the famous running battle between the people and the grammarians has become a thing of the past. The people have won and the grammarians have lost. The split infinitive, the preposition at the end and all the rest of these poor struggling usages have finally arrived.

What has happened is this. The old school of thought in the field of English grammar was that of the 18th-century grammarians, who started the whole business from scratch, so to speak. These old scholars—most of them were retired clergymen—tried to develop a system of English grammar where there hadn't been one before and, naturally, used the system most handy and familiar to them, namely that of Latin. Ever since,

Watch Your Language! Try to Be Natural, Not Pompous

Natural	Pompous	Natural	Pompous	Natural	Pompous
about	as to, with regard to	get up	arise, rise	say	state, remark
after	subsequent to	girl	young lady	seem	appear, would seem
answer	reply, response	give	contribute	send	forward, transmit
ask	consult, inquire	happen	transpire	show	evidence, indicate, reveal
be grateful for	appreciate	help	assist	since	inasmuch as
be sorry	regret	hopeful	optimistic	smell	odor
because	inasmuch as	house	residence	so	thus
before	prior to	I	the writer	start	commence, initiate
begin	commence, initiate	If	in the event that	stop	terminate
building	edifice	job	position	suppose	presume
buy	purchase	keep	retain	tell	inform
call for	necessitate	know	be aware of	that	which
do	achieve, accomplish	live	dwell, reside	think	deem
end	terminate	look for	seek	think of	consider, contemplate
enough	sufficient	make	render	town	community
expect	anticipate	make easy	facilitate	try	endeavor
feel	experience	meet	make the ac- quaintance of	underrate	minimize
find	locate	much	materially, substantially	understand	appreciate
find out	ascertain, determine	need	require	use	utilize
first	primary	now	at this time	want to, wish	desire
for	for the purpose of	of	relative to	work for	be associated with
get	acquire, obtain, receive	person	individual		
		place	locality		
		put	place		
		read	peruse		
		remember	recall		

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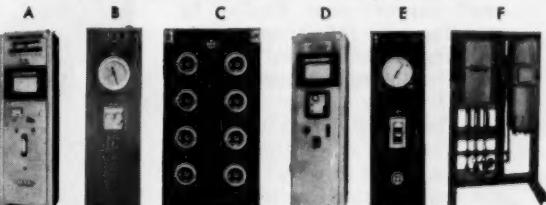
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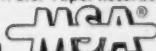
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English and American school children have been taught Latin rules of grammar.

Around 1900, scientific linguists entered the field and began to shake their heads at the nonsense that was taught in the schools. To a scientist, what there is, is, and if people go around splitting infinitives whenever they feel like it, that's an interesting development but not a "mistake." If a split infinitive is a mistake in English usage, then a live platypus is a mistake in biology.

Science Triumphs

The battle raged for over 50 years. More and more English teachers and textbook writers went over to the scientific camp until finally the triumph of science was complete.

In 1950, there appeared the revised edition of "Writer's Guide and Index to English," by Professor Porter G. Perrin, which as I said, is now the most widely used college composition text in this country. (Dr. Perrin's strictly scientific statements on current usage are also given in the well-known Thorndike-Barnhart series of dictionaries.)

Then came, in the fall of 1957, the "Dictionary of Contemporary American Usage," by Professor Bergen Evans and his sister, Miss Cornelia Evans. No comparable reference book in the field of American usage exists and it seems clear that the Evans dictionary will be the standard authority for years to come.

I went through both of these books and noted down what they said about some two dozen of those famous arguments. I've tabulated my findings above.

All right, have I satisfied your curiosity? Let's go on to the more important things. If you can't improve your English by avoiding split infinitives and refraining from "It's me," can you do it by increasing your vocabulary? Many people think so and there are dozens of books and hundreds of courses on the market. Does it work? Is this the way to better English? Let's see.

Vocabulary building is a much more recent invention than "correct grammar." Vocabulary

building started only 24 years ago with an article in *The Atlantic* called "Vocabulary and Success." The idea was that if you add to your vocabulary, you'll go up in the world. Spend 15 minutes a day with such words as internecine and matutinal, and you'll be on your way.

Are You Socially Inferior?

Maybe that was true 24 years ago—although I very much doubt it—but it most certainly isn't true today. As a matter of fact, a large vocabulary nowadays may actually hinder your success—because it marks you as socially inferior.

How can this be? you say. Well, it's very simple. If you belonged to the privileged few, if you have spent your life going from prep school to an Ivy League college to a professional or executive job with a large corporation, then you obviously never had to worry about enlarging your vocabulary. The words suitable to your way of life simply accumulated in the course of the years.

On the contrary, as time went on, it became important to limit your vocabulary—that is, stick to the language of easy informality that is now the accepted standard everywhere. As Dr. Bergen Evans has said, today we address strangers as if they were our intimate friends. If you want to do well in an executive job, vocabulary building would be sheer poison.

If you were not born and raised to fill an executive's chair, but are just an ordinary middle-class person working for a living, the same principle holds true. If you want to become an executive,

then you'd better speak, write and behave like one. Vocabulary building will get you nowhere; vocabulary limitation might.

Avoid Pompos Equivalents

However, I realize that it is not as easy as it seems to speak and write the modern, limited-vocabulary, "executive" English. The temptation to use pompous equivalents for everyday words is awfully strong.

So to help you in your daily struggle against this temptation, I've drawn up a list of the most common of these "social mistakes." (Let me warn you: It seems easy to avoid the pompous words in the right-hand column, but actually it's extremely difficult.)

If you compare this list with the earlier one of disputed usages, you'll see that the trend in grammar is exactly parallel to that in vocabulary. This is the age of informality, and if you want to improve your English you must first of all learn to relax.

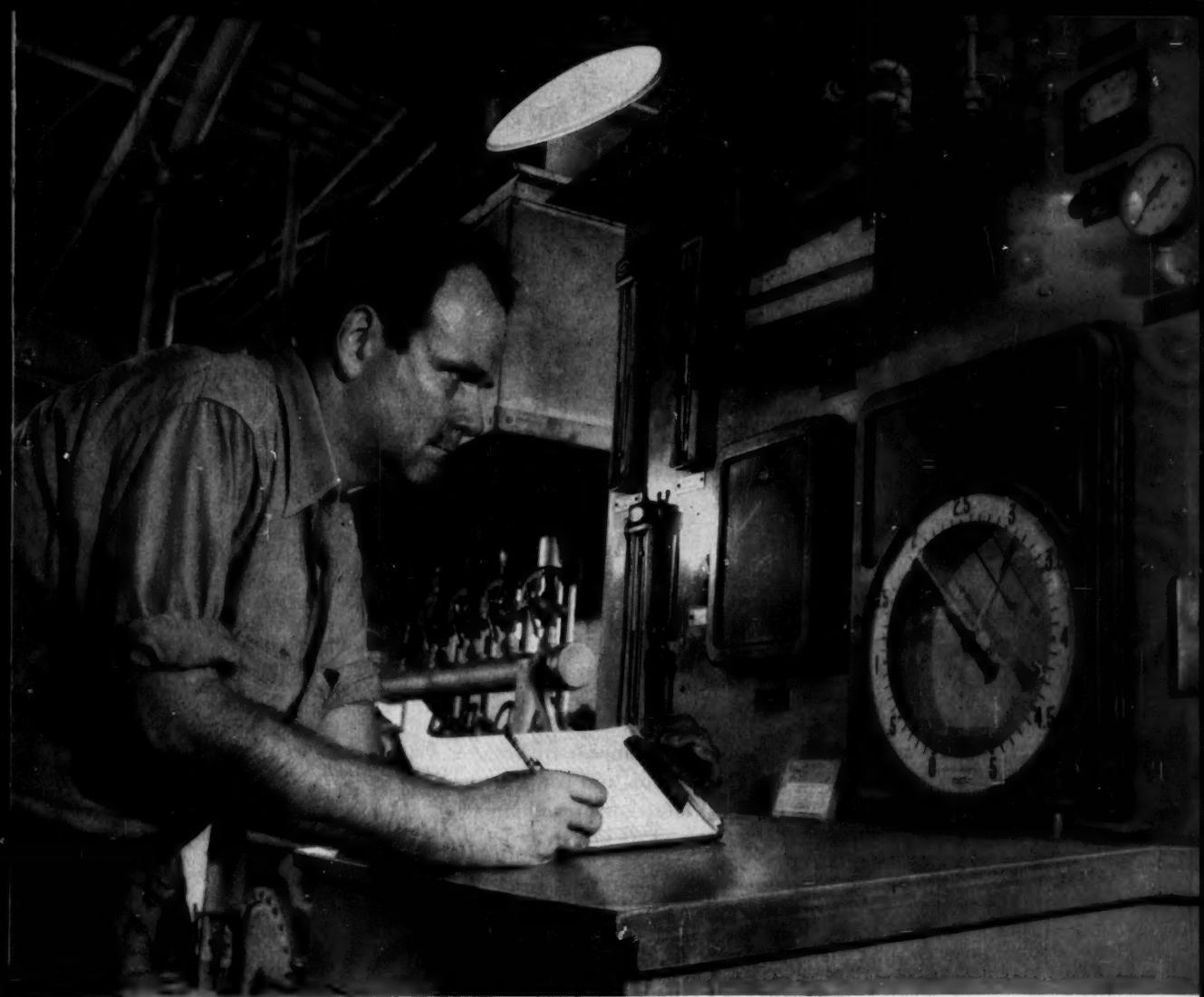
Lean Back and Relax

I shall try, in the rest of this book, to convey to you some of this relaxed feeling about writing—the sense of knowing how to tackle a writing job with ease and confidence. Some of it comes from just plain practice—and some comes from a knowledge of the techniques and devices used by many of today's professional writers.

Better English doesn't mean grammar or vocabulary or spelling or punctuation or whatnot; it means feeling fully at ease whenever you are speaking or writing.



RUDOLPH FLESCH has also authored "The Art of Plain Talk," "How to Test Readability," "How to Make Sense" and (probably the most controversial) "Why Johnny Can't Read."



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PRACTICE . . .

OPERATION & MAINTENANCE

EDITED BY M. D. ROBBINS

Preventive Maintenance Code

- P. M. 0 Allowed random maintenance.
- P. M. 1 Erratic repairs to equipment covered by P. M.
- P. M. 2 Inspection and/or minor adjustments.
- P. M. 3 Intermediate P. M.—repairs aimed at replacing or repairing a specific component.
- P. M. 4 General P. M. overhaul—repairs designed to put equipment in best practical condition.
- P. M. 8 Corrective maintenance.

Solving maintenance problems with a . . .

Program for Prevention

Successful preventive maintenance requires cooperation, workmanship, administration and control.

Here's how you can tie these loose ends together.

RALPH N. PRICE, Maintenance Superintendent,
Columbia-Southern Chemical Corp., Corpus Christi, Tex.

Concepts of good maintenance have changed appreciably over the past 10 or 15 years. At the same time, the mechanics of controlling and evaluating the maintenance function have also changed quite radically, especially when compared with those followed a decade ago.

For example, a centralized planning and scheduling department, once considered not only impractical but absolutely unnecessary, is now accepted as a very essential part of the maintenance organization.

It wasn't too long ago that any kind of red tape was, to put it mildly, frowned on by top management and most people. Now, we all recognize that records, adequate control statistics

and a good work-order system are essential.

Preventive Maintenance Concept

We started a formal preventive maintenance program in 1945. Techniques and methods have changed considerably since that time, but basic philosophy remains fairly constant.

Extremes in maintenance policy are best defined by comparing a policy designed to eliminate all failures against a policy not allowing any preventive maintenance.

You can plot a course somewhere between these two extremes. However, preventive maintenance practices must vary occasionally to compensate for changes in sales demands or other factors.

Cooperation Is Important

Most important requirement of a successful maintenance program is complete understanding and cooperation between maintenance and production.

RALPH N. PRICE has been with Columbia-Southern for nearly 26 years and has been maintenance superintendent for the last 12 years. He's a native Texan and has long been known in the maintenance field.

Maintenance must understand and appreciate that the production man is almost always faced with the problem of maximum production while keeping his equipment maintained at an optimum level. Production supervisors must be willing to do a certain amount of forecasting, based on production demands, and place some faith in predictions of repair time made by the maintenance department.

Exact reasons for equipment failures are seldom clearly defined and responsibility for production loss caused by such failures must generally be shared jointly by maintenance and production.

Ingredients of a successful preventive maintenance program are summarized as follows:

- Mutual understanding between production and maintenance.
- Good maintenance records.
- Good workmanship on the part of maintenance mechanics.
- Adequate inspection program.
- Good corrective maintenance program.
- Good administration of the over-all program. Mechanism of operating a preventive maintenance program is vital to its success, and it requires a man of above average ability to do the job well.

For this discussion we'll think of preventive maintenance as applying only to mechanical equipment in production areas. Much of the maintenance work on buildings and other structures can certainly be classified as preventive but the definition we'll stick to applies only to production equipment.

We also have an extensive preventive maintenance program covering electrical equipment, but the procedures and techniques are somewhat different so we won't cover them in this article.

Within these limits, preventive maintenance is classified



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ESCE No.
CORPUS CHRISTI, 10-552 Maintenance Work Order No. T6581

DATE ISSUED	10-20-58	ORDERED BY	Ludden <i>328</i>	Dept.	Unit	Div.	Item		
DATE CLOSED	30	APPROVED BY	<i>70 Wmip</i>	22	1		413		
ISSUED TO	30	START		FINISH					
PRIORITY	2	JOB CLASS	1	C.C.	1	PM CODE	1	JOB SUB	5
JOB DESCRIPTION:									
Open, check and clean rotor on Booster Blower.									
Sch. for 10-21-58									
JOB REQUIREMENTS FOR MAINTENANCE COORDINATORS USE ONLY									
Craft	Sec.	DESCRIPTION OF JOB STEP	ESTIMATED	Men Hours	Men Hours	Std-H			
371	1	Remove Suction Pipe	2	6	12				
371	1	Assess Disc filters	2	4	8				
300	1								

under one of the following headings and coded as shown in the table above.

Inspection—Although nearly all preventive maintenance jobs are in some respect for inspection purposes, inspection procedures are aimed at things detectable while the equipment is in operation. For mechanical equipment, formal inspections are made every three months. We're currently considering lengthening this interval.

Intermediate Repairs—These preventive maintenance repair jobs are primarily directed at replacement of a specific component (or components) of a unit.

General Repairs—General preventive maintenance overhaul is designed, within practical limits, to put a piece of equipment back into perfect shape.

Corrective Maintenance—After a preventive maintenance program has reached a certain level, corrective maintenance is a fertile field for cost control and improvement.

There are, of course, practical limits beyond which preventive maintenance doesn't pay. It's within this area that most mechanical maintenance falls—either as "regular" or "emergency" work.

Included under regular maintenance is work that doesn't fall into recognizable patterns and must be handled on a day-by-day basis. Of course, emergency work is done when equipment breaks down unexpectedly.

At Corpus Christi the major-

ity of our pumps, and all motors under 50 hp., are excluded from the preventive maintenance program. Most of the small pumps are "spared" and run to failure without inflating maintenance costs.

Average life of a small electric motor is around seven years and replacement of these motors on a planned basis isn't justifiable economically.

This equipment is covered with the inspection procedure and quite a few incipient failures are caught in this manner. However, a good share of the work on equipment of this nature is initiated by production supervisors and handled with relatively little advance notice.

Approximately $\frac{1}{2}$ of our maintenance man-hours (excluding custodial services) are expended on mechanical repair. These hours are apportioned about as follows: 5% on breakdown work; 5% for inspections; 50% on regular maintenance; 20% on intermediate repairs; and 20% for general repairs.

Record Keeping

Under the direction of the preventive maintenance engineer, detailed historical records are kept on all production equipment. These records are accumulated in two files: a McBee punch card file and VISIrecord file.

All mechanical maintenance must be charged to a work-order number. A typical filled in work order is shown on page 196.

McBee cards are made out for each work order. This card duplicates the original work order and records deviations from the original description. On the back of the card is a record of maintenance manhours, total labor charges and total material charges. Punched coding covers the cost center and equipment number, month and day the work order is closed, size of the job, priority of the job and the source characteristic of the job.

Naturally, a code is necessary for equipment. This code identifies a specific production "job" or location. Each item number is unique within a given department. Item numbers are assigned by type of equipment:

100—199	Pumps
200—299	Motors
300—399	Tanks
400—499	Compressors, blowers and fans
500—599	Elevators and conveyors
600—699	Process equipment
700—799	Miscellaneous

On mechanical equipment, we try to identify the critical component that caused, or would have caused, the repair. Critical component code for pumps is shown below. Coding varies for each major equipment group.

The preventive maintenance engineer is responsible for follow-up, analysis and recordkeeping on mechanical equipment. The line organization is expected to contribute heavily to the program, but it takes one man full time to handle the mechanics of this very important job.

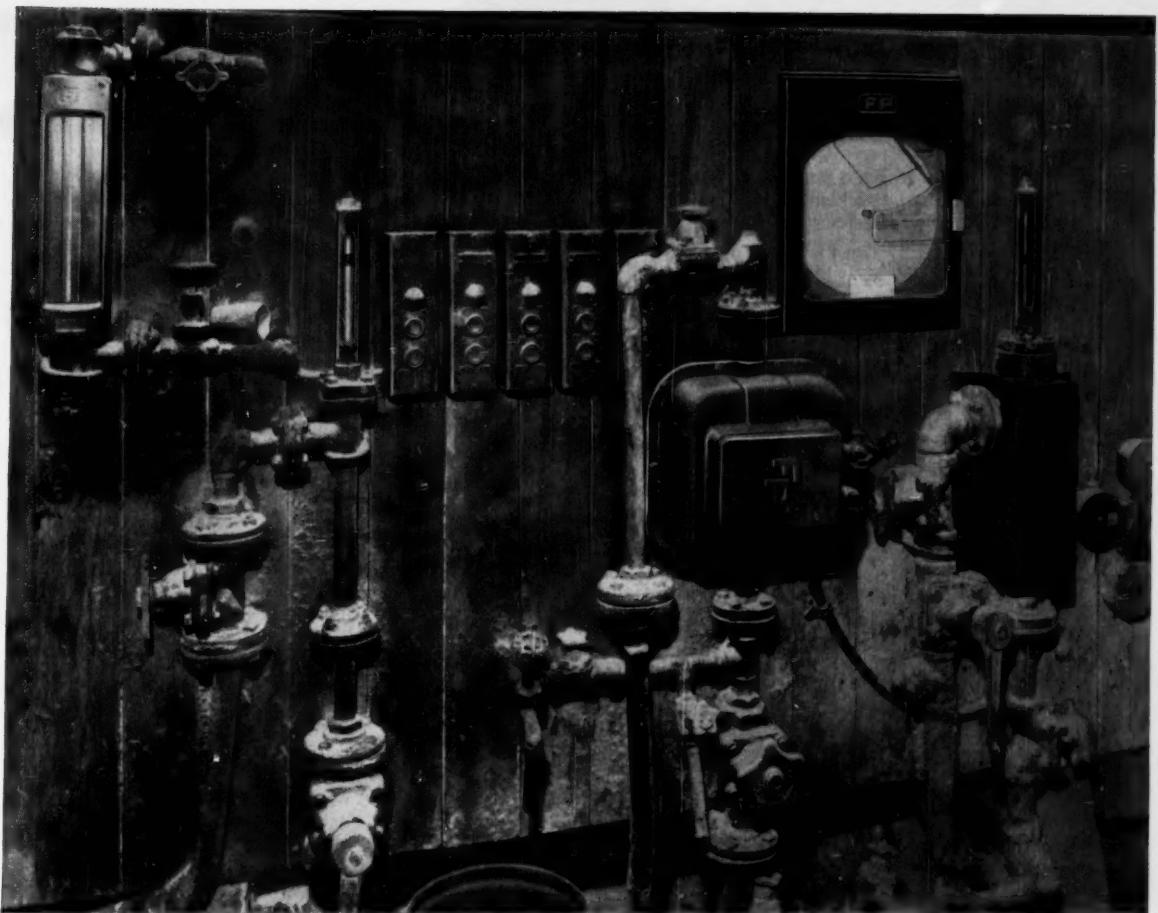
VISIrecord files cover all mechanical equipment and are used solely for preventive maintenance. Information important for predicting future preventive maintenance work is abstracted from the McBee cards and posted to the VISIrecord cards.

For follow-up on preventive

Critical Component Code

Example: Item 100 (pumps)

Code	Code
0 Overhaul	5 Sleeve
1 Bearings	6 Shaft
2 Head	7 Rings
3 Casing	8 Wear plate
4 Impeller	9 Packing



One-inch F&P magnetic flowmeter measures wet process phosphoric acid to an accuracy of better than $\pm 1\%$, independent of viscosity, density, or piping configuration at Baltimore, Maryland plant of Fertilizer Manufacturing Cooperative.

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Unlike conventional meters, the corrosion-proof, erosion-proof F&P *magnetic* flowmeter has no pockets or stagnant areas where solids can collect . . . no obstructions to cause pressure drop. And rate of flow is measured to better than $\pm 1\%$ accuracy—*independent* of viscosity, density, or turbulence.

Other standard F&P features permit any F&P secondary instrument to be used with *any* F&P magnetic flowmeter. No custom matching necessary. Recorders are ideally suited for either volumetric or gravimetric record-keeping. And a simple in-case adjustment provides the same accurate direct reading gravimetric measurements despite changes in specific gravity.

Get the facts on the F&P magnetic flowmeter NOW! Contact the F&P field engineer nearest you, or write for Catalog 10D1416. Fischer & Porter Company, 149 County Line Road, Hatboro, Pa. In Canada, write Fischer & Porter (Canada) Ltd., 2700 Jane Street, Toronto, Ontario.

FP FISCHER & PORTER COMPANY

COMPLETE PROCESS INSTRUMENTATION

maintenance, a chronological tickler file is kept. When a posting is made to the VISIrecord file a prediction is formulated and a card is placed in the tickler file. Most of these predictions fall into the "intermediate" preventive maintenance category.

This Is How It Works

Inspection Program—Routine inspection of mechanical equipment initiated by the preventive maintenance engineer. An inspection route, and a corresponding check list for each piece of equipment on the route, is developed for each department. These inspections are made by a first-class mechanic and cover only defects detected by light, sound or touch while the unit is operating.

Inspections are made every three months. Results of the inspections are turned over to production supervisors who initiate requests for corrective action.

Intermediate Preventive Maintenance Overhauls—Preventive maintenance overhauls aimed at replacement or repair of a specific component are classed as intermediate P.M. overhauls. Generally this type of preventive maintenance isn't set up at predetermined intervals but projected from one job to the next by the use of the tickler file. This is the most practical method for handling preventive maintenance on large, complex equipment.

General Preventive Maintenance Overhauls—Within practical limits, general overhauls are designed to return equipment to original condition. Equipment is covered on this basis when the pattern of repairs is such that the work can be performed at regular, predetermined intervals. This is the ideal form of maintenance. We continually strive to place more equipment in this category.

Corrective Maintenance—This is the phrase most generally used to describe a program designed to pick out and correct flaws in production equipment. More apt a term is "improvement" maintenance.

Ultimate, although unattainable, goal of such a program is bringing all components in each piece of equipment into perfect

balance—so that each part wears out at the same time. All production equipment is covered in this program regardless of status in the preventive maintenance program.

When starting up a new plant, or in dealing with new installations, weaknesses usually develop early and the outstanding trouble spots are easily recognized. As these are corrected a routine approach designed to identify the less obvious weaknesses becomes increasingly important.

Routine approach to corrective maintenance involves identifying the "critical component" in each mechanical repair. Stated another way, picking out and improving the weakest link in each piece of equipment.

Information of this nature is punched into the McBee card record of each overhaul. It's easy to sort these cards by equipment numbers and make an analysis on the basis of information so recorded.

When probable trouble spots are identified, a more complete investigation is made. Reasonably often, changes are made bringing the equipment into better balance.

Control and Evaluate

No single denominator has been devised for evaluating maintenance in an industrial plant. This is particularly true in the process industry where inter-relations between individual pieces of equipment and major groupings of equipment is so important.

There are, however, a number of indicators used for controlling and evaluating the preventive maintenance function. Statistics used for measurement purposes are as follows:

- Ratio of emergency (or breakdown) maintenance to total maintenance.
- Ratio of overtime hours to total hours.
- Percent compliance with the daily work schedule.
- Ratio between actual production and rated capacity.
- Maintenance man-hours per unit of production.
- Frequency of maintenance jobs, broken down by cost centers and into grouping of similar equipment.

• Ratio of preventive maintenance to total mechanical work.

There's a linear relationship between most of these factors. When one variable goes up or down, expect its associated variables to follow the same pattern. When one or more of the variables don't follow this pattern over an appreciable length of time take it as an indication of a change—either good or bad.

Most of these factors are relevant to the problem of control when considered individually. When setting up this program, historical data over a base period were used as a criteria. Ideals were established for some factors and upper and lower limits for others. Of course, when frequency limits are established mathematically, using past history as a base, there's generally room for improvement.

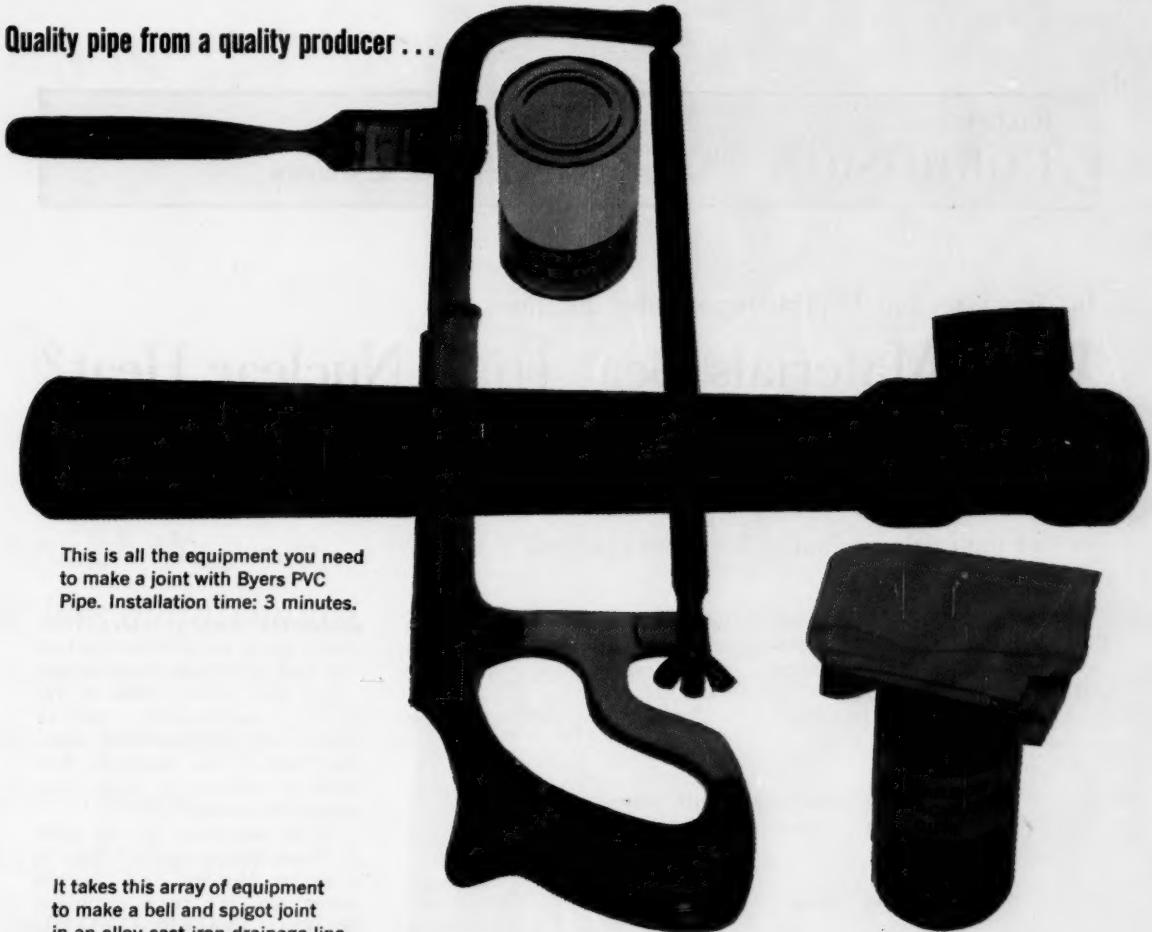
When each of the factors listed above are recorded in a systematic manner and analyzed regularly, it's relatively simple to spot trends quickly. However, examine these trends critically and don't place too much weight unless continued over a reasonable length of time or reflected in associated variables.

Maintenance management's ability to interpret control statistics should continually improve. This in turn brings about more reliable forecasting and allows the transfer of a larger proportion of mechanical work from regular to preventive maintenance.

When you can use upwards of 90% of the useful life of a piece of equipment and still get it down for repairs before it breaks down, then preventive maintenance is very attractive. This not only gives maximum production but lowest maintenance costs. Under this program you do a better job of planning and scheduling, improve control of spare parts and reduce the peaks and valleys in the flow of maintenance work.

Preventive maintenance is just a part, although a vital part, of the over-all maintenance program. A good preventive maintenance program goes right along with good planning and scheduling, an adequate work order system, and of course, good management.

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PVC's lighter weight makes a 20-foot length easier to handle than a 5-foot length of high silicon cast iron. PVC is almost one-tenth the weight of such materials. Any repair work or line alterations can be done quickly and easily with PVC Pipe, at a very low cost. Some competitive materials are virtually impossible to repair.

PVC lasts and lasts: For drainage systems, Byers PVC has good physical properties combined with very high corrosion-resistance. You don't find the brittleness in PVC that characterizes some ferrous and glass materials. Smooth walls assure excellent flow conditions. Physical properties do not deteriorate with age.

For more information: If you would like to know what we already know about PVC pipe in drain and sewer lines, contact the Byers field service engineer. And write us for comprehensive new PVC Catalog. A. M. Byers Company, Clark Building, Pittsburgh 22, Pennsylvania.



BYERS PVC PIPE also sheet and rod stock

PRACTICE . . .

CORROSION FORUM

EDITED BY R. B. NORDEN

In New Gas- and Liquid-Metal-Cooled Reactors . . .

What Materials Beat High Nuclear Heat?

New process heat and propulsion reactors will operate above 1,470 F. Here are advantages and disadvantages of materials evaluated for these reactors.

High temperature—a term badly in need of a good definition—is getting more attention in nuclear reactor designs.

It looks very much like high-

temperature operations will be one answer to many of the economic problems now plaguing the nuclear field.

For instance, one promising

design for power reactors is the closed-cycle gas-turbine system—a high-temperature situation.

But also other types of reactors, particularly nuclear rocket and process-heat reactors, now in the limelight, will have to operate at high temperatures—over 1,470 F.

What materials can be used at these temperatures? This is a major problem and the answers are far from complete. However, one phase of this work—high-temperature cladding and matrix materials—has yielded a spate of information on advantages and disadvantages of metallic and nonmetallic materials. Many of the materials are familiar to most chemical engineers, and the data could easily be applied outside the nuclear field (see tables).

Coolants for high-temperature reactors are almost exclusively gaseous. Liquid metals may serve the temperature range 1,470-2,190 F. Above this only gases are sufficiently stable as heat-transfer media. Gas coolants most frequently considered are air, N_2 , CO_2 , He and H_2 .

► **Series Effects**—But, for these nuclear applications, materials must pass some stiff requirements. Corrosion resistance becomes crucial even in helium and hydrogen. Small amounts of impurities can have a serious effect on graphite, molybdenum, tantalum, columbium. Poor thermal conductivity and high

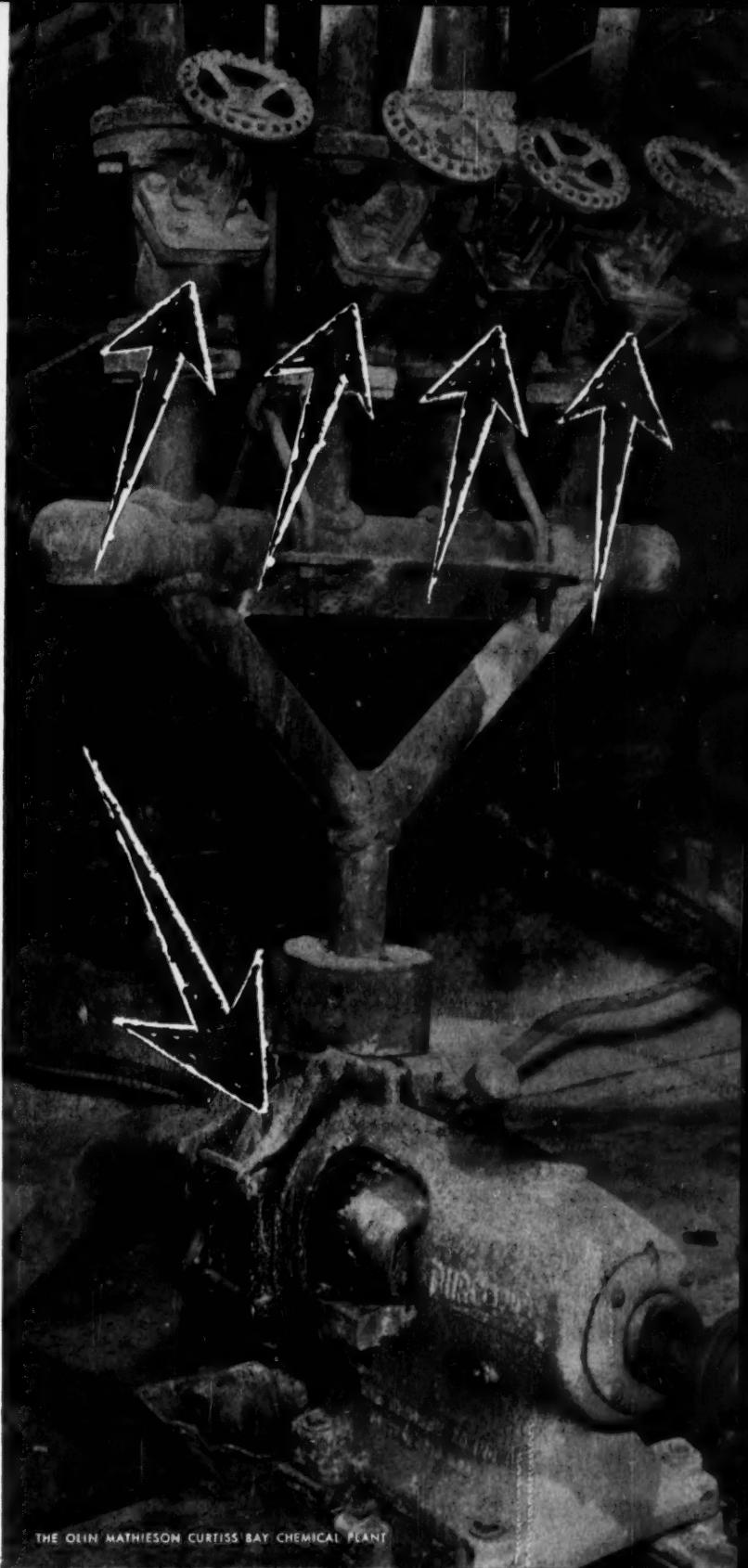
High Melting Point Metals

Stability in Various Coolants	Melting Point, °F.	Thermal Neutron Absorption Cross Section, σ_a (barns)
W: poor oxidation resistance. Good stability in hydrogen to high temp., Hg to 1,110F., Pb-Bi to 930F., Na and NaK to 1,470F.	6,115	19.2
Re: poor oxidation resistance.	5,756	84.4
Ta: poor oxidation resistance. Good stability in Pb-Bi, Na, NaK, Li to 1,650F., Pb to 1,830F. Poor resistance to Hg.	5,425	21.3
Mo: poor oxidation resistance. Good stability in hydrogen to high temp., Hg to 1,110F., Li, Na, NaK to 1,650F., Bi to 1,830F.	4,750	2.5
Cb: poor resistance to oxygen, hydrogen. Good resistance to Bi to 1,470F., Pb, Li, Na, NaK to 1,830F.	4,479	1.1
V: poor resistance to oxygen, hydrogen. Good resistance to Na, NaK to 930F., Pb-Bi to 1,200F.	3,450	5.1
Cr: good oxidation resistance to 1,290F. Alloys with more than 30% Cr good to 1,830F. Probably good resistance to Hg to 930F., Bi to 1,470F., Na, NaK to 1,650F.	3,407	2.9
Zr: poor resistance to oxygen, nitrogen, CO_2 above 840F. Poor resistance to hydrogen, Hg. Good resistance to Pb, Na, NaK to 1,110F.	3,365	0.18
Th: poor oxidation resistance in air. Poor resistance to Bi, Pb. Good resistance to Na, NaK to 1,110F.	3,090	7.5
Ti: good resistance in air, to 1,110F., nitrogen to 1,830F. Poor resistance to hydrogen. Good resistance to Pb, Na, NaK to 1,110F.	3,040	5.6

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longer service life,
and dependable
performance,
*Olin Mathieson
Chemical Corp.
has used***

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and
DURCOPUMPS**

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THE OLIN MATHIESON CURTISS BAY CHEMICAL PLANT

CORROSION FORUM . . .

modulus of elasticity of many high-temperature materials often limit the safe heat generation rate. Undesirable reactivity between fuels and other materials is greatly aggravated by temperature.

Metals, intermetallic compounds, ceramics and cermets can be used for either cladding or matrix.

► **Metal Advantages** — The advantages of metals are they can be fabricated and sealed more

easily than intermetallics and ceramics, and they have better thermal conductivity and thermal shock resistance. The potentially useful metals are summarized in the table.

Columbium and molybdenum are two of the most promising high-strength materials. Unfortunately, they are very sensitive to small amounts of impurities in the coolant; oxygen is a particularly offensive impurity. An oxidation-resistant alloy or coating is required, or else the maximum operating temperature of the materials will be determined by the purity content of the coolant.

Effects of radiation on metals are expected to be minimized because of the annealing effect of the high temperatures.

► **Exploit Intermetallics** — Some of the known intermetallic compounds are also summarized in the table. The full potential of this group of materials has not been exploited. They are as difficult to fabricate as ceramics; however, they should have better thermal conductivity and thermal shock resistance.

There are, also, a number of potentially useful ceramics. Major general limitations of ceramics are their poor thermal conductivity, poor thermal shock resistance and poor resistance to thermal stresses. Materials with good thermal conductivity are then of prime importance. The most promising are graphite, silicon carbide, zirconium carbide and beryllium oxide. Aluminum oxide, though not having as good thermal conductivity, is promising because of its low absorption cross-section and known technology. Again, radiation effects will be less pronounced at high than at low temperatures.

► **Graphite Is Special** — Graphite deserves special mention as one of the most useful high-temperature nuclear materials. It has good strength at very high temperatures (to 4,530 F.), excellent thermal conductivity, thermal shock resistance, and nuclear properties. For this reason the majority of high-temperature reactors plan to use graphite-base fuel elements. Carbide coatings being

High Melting Point Intermetallic Compounds

Stability in Various Coolants

Zr ₂ Ge	
CrAl:	fair oxidation resistance in 2,010F. air.
Mo ₂ Al:	good oxidation resistance 100 hr., at 2,100F. air. Poor oxidation resistance at 2,010F.
Zr ₂ Sb	
ZrBe _{1/2} , ZrBe _{2/3} , ZrBe	
CrBe ₂	
Cr ₂ Si	
MoAl	
ZrCr ₂	
V ₂ Al ₅	
Ti ₂ Sn	
NiAl:	good oxidation resistance in 2,100F. air.
ZrAl ₃ :	poor oxidation resistance in 2,010F. air.

Melting Point, °F.

4,127
3,920
3,902
3,452
3,344
3,344
3,146
3,092
3,047
3,038
3,025
2,984
2,984

High Melting Point Ceramics

Stability in Various Coolants

Graphite and Carbides: In general carbides have poor oxidation resistance to air; exceptions are SiC to about 2,910F. and Cr₃C to 1,830F. Carbides should be stable in hydrogen; graphite probably forms hydrocarbons at high temperatures. The resistance of graphite to CO₂ is better than to air, but still limited to less than 1,650F. Be₂C is not resistant to moisture and nitrogen. TiC and CbC are stable in nitrogen to 4,530F. Graphite is resistant to liquid Bi. TiC is resistant to Na, NaK.

4TaC • ZrC	
TaC	
ZrC	
Graphite	
CbC	
TiC	
WC	
VC	
Mo ₂ C	
ThC	
SiC	
Be ₂ C	
Cr ₃ C ₂	

Melting Point, °F.

7,106
7,016
6,386
6,332
(decomp)
6,332
5,684
5,198
5,126
4,874
4,766
3,992
3,902
3,434

Nitrides: generally have poor oxidation resistance. Si₃N₄ appears to be an exception; it has good oxidation resistance to 2,550F. The nitrides should be stable in hydrogen and nitrogen. ZrN has good resistance to liquid Bi and probably alkali metals as well.



PILOT PIPE

"U.S." "straight-through" pipe requires no flanges. Simply cut to size, slip over pipe and clamp on.

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you need
a real
twister

...Get U.S. Pilot Pipe!

This limber, highly abrasive-resistant U. S. Pilot® Pipe is at work 7 days a week, 24 hours a day (during the 6-month concentrating season) in the heavy media department of the beneficiation plant of a large iron ore producer. It carries 200 gallons per minute of ferro silicon into a magnetic separator.

BIG REASONS WHY U. S. PILOT PIPE IS USED:

- Company records show that U. S. Pilot Pipe lasts about 12 times longer than metal pipe.
- Maintenance is nil.
- Pilot Pipe is so flexible it permits an easily formed angle,

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U. S. Pilot Pipe includes a wide range of designs ("straight-through", duck and rubber flanges, swivel flanges) that handle a wide range of working pressures—from 25 to 250 pounds—and also handle a wide range of chemicals and abrasives.

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Rockefeller Center, New York 20, N.Y.

In Canada: Dominion Rubber Company, Ltd.

Continued from pg. 204

High Melting Point Ceramics

Stability in Various Coolants

TaN	
ZrN	
TiN	
ThN	
AlN	
Be ₃ N ₂	
Ba ₂ N ₂	
CbN	
VN	
Si ₃ N ₄	

Oxides: in general are the most stable materials in air; some exceptions at high temperatures are CaO, NiO, TiO₂, BaO, SrO, Cr₂O₃. Oxides are generally stable in hydrogen; some exceptions are: MgO, CaO, SiO₂, CeO₂, Cr₂O₃, NiO, TiO₂, BeO. Some oxides are sensitive to water vapor: MgO, BeO. The poor thermal conductivity of oxides would not make them a logical choice for use with high heat removal capacity coolants such as liquid metals.

ThO ₂	
SrO + ZrO ₂	
BaO + ZrO ₂	
ZrO ₂	
CeO ₂	
CaO	
BeO	
3BeO + 2ZrO ₂	
ZrO ₂ SiO ₂	
SrO	
Y ₂ O ₃	
CaO + ZrO ₂	
Cr ₂ O ₃	
CaO + Cr ₂ O ₃	
MgO + Al ₂ O ₃	
2CaO + SiO ₂	
Al ₂ O ₃	
NiO + Al ₂ O ₃	
SrO + Al ₂ O ₃	
BaO + Al ₂ O ₃	
NiO	
BeO	
BeO + Al ₂ O ₃	
TiO ₂	
3Al ₂ O ₃ + 2SiO ₂	
2BeO + SiO ₂	
SiO ₂	

Silicides: generally have good oxidation resistance by virtue of the formation of a protective SiO₂ film. MoSi₂, TaSi₂ are good in air to 2,730°F. CbSi₂, ZrSi₂ and VSi₂ are said to have promising oxidation resistance. Considering the limited resistance of SiO₂ to reducing atmospheres and water vapor, one would not expect silicides to be resistant to such atmospheres.

Ta ₅ Si ₃ , Ta ₂ Si ₃	
Cb ₂ Si ₃	
W ₂ Si ₃	
Zr ₂ Si ₂ to Zr ₅ Si ₄	
TaSi ₂	
Mo ₂ Si ₃	
WSi ₂	
V ₂ Si ₃	
Ti ₂ Si ₃	
MoSi ₂	
CbSi ₂	

Melting Point, °F.
5,396
5,396
5,342
4,280
4,046
3,992
3,992
3,686
3,686
3,452
(decomp)

developed for graphite (ZrC, TiC, SiC, CbC) will tend to make graphite a more useful material in a variety of atmospheres.

Of the large number of cermets made to date, Al₂O₃-Cr and SiC-Si have been suggested and tested for fuel elements.

► **What About Reactivity?** — Fuels are dispersed in a matrix to increase thermal conductivity of the element, to dilute enriched fuel, and to mechanically strengthen the element. The function of the cladding is to prevent fuel and fission product diffusion, and to protect the fuel from corrosion. At high temperatures the chemical reactivity of the fuels with respect to matrix and cladding increases and imposes some limitations on fuel-matrix combinations.

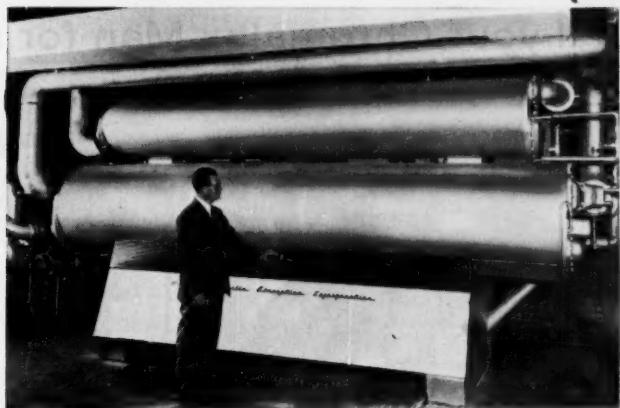
Very little information is available on the reactivity of fuels with refractory metals. UO₂ probably does not react with Cb and Mo. Tests of a UO₂-Cb diffusion couple for five days at 2,500 F. did not show a significant reaction. Reaction between UO₂ and Zr becomes significant at 930 F. The reaction between UC and Zr requires 1,830 F. At this temperature it appears to proceed rapidly.

UO₂ would generally not be expected to be stable in carbides at high temperatures. There is a reaction between UO₂ and graphite to form UC and CO; the rate of reaction increases rapidly with temperature, particularly above 2,190 F.

The relationships between UC and refractory materials are even less well known than those for UO₂. Complete solid solutions are formed with ZrC, ThC, TaC, and CbC. Less complete x-ray examinations found partial solubility with TiC, VC, Cr₂C, Mo₂C, WC and Be₂C. No mutual solubility was found in the UC-SiC and UC-Cr system. Both UC and UC₂ have good stability in graphite; UC₂ is the stable form in graphite above about 3,630 F. The volume change occurring in the UC to UC₂ transformation is relatively small.

4,532
4,496
4,244
4,010
4,082
3,992
3,974
3,938
3,902
3,848
3,686
3,506

Based on a paper "High-Temperature Fuel Elements," by A. Strasser, Nuclear Development Corp. of America, given at the First International Symposium on Nuclear Fuel Elements, Columbia Univ., Jan. 28-29, 1959.



For reliable cooling
from low-cost heat

29 leading U.S. chemical producers use Carrier Absorption Refrigeration

In the last seven years 29 leading U.S. chemical companies have purchased Carrier Absorption Refrigerating Machines. They deliver a total of 19,470 tons of cooling, range in capacity from 60 to 700 tons and help produce such varied products as baby powder, explosives, table salt and vinyl plastics.

Why have these companies chosen Carrier Absorption Refrigeration—and why have so many of them become repeat buyers? One reason: economy. Cooling produced by low-pressure steam or hot water is often the best way to handle refrigeration requirements in a processing plant. Another reason: reliability. For years Carrier Absorption Machines have established an unmatched record for dependability in more than 1000 installations throughout the world.

Of course, there are other reasons. So the next time you need refrigeration, why not call Carrier and get the whole story? Call your nearest Carrier office. Or write Carrier Corporation, Syracuse 1, New York.



Automatic STOP-and-GO is just one of many features of the Carrier Absorption Machine. No valves to turn, no switches to throw. Just a single push button for "Stop-and-Go." The human element can be eliminated altogether by use of a time clock or thermostat.



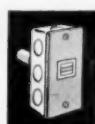
Push Button

Starts and stops the machine at the press of a single button.



Time Clock

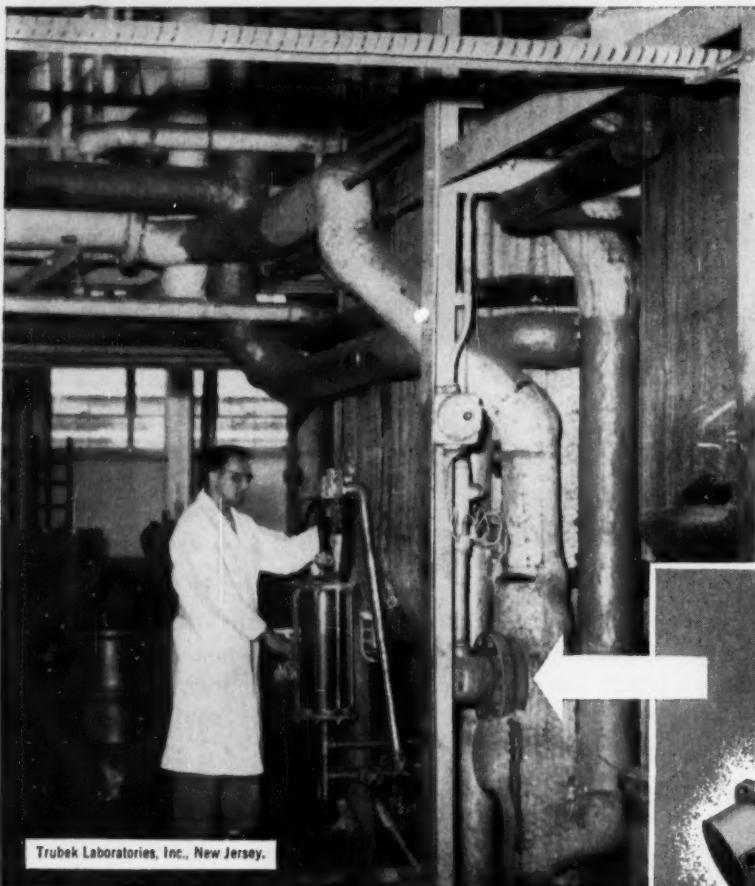
Automatically starts or stops machine at any hour you select.



Thermostat

Automatically starts or stops machine at desired temperature.

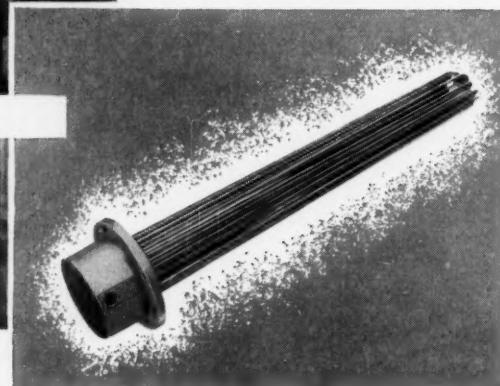
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Trubek Laboratories, Inc., New Jersey.

When temperature requirements could no longer be met by a hot temperature oil central system, Chromalox "job-side" heating provided the answer.

Widely different temperature requirements on various processing vessels



Recently, this New Jersey company converted an old hot-oil central system to Chromalox electric "job-side" heating. In addition to being troublesome, the old system could not provide the variety of temperatures required for their growing diversity of products. Switching to Chromalox Immersion Heaters, they now use Aroclors and Dowtherm as heat transfer media. On one 350-gallon vacuum still, 18kw of heat capacity now provides temperatures of 290°C. Chromalox Type TMO Immersion Heaters operate in the bottom of the vented vessel jacket which contains the heat transfer medium. Using 30kw, a 450-gallon sealed jacket reactor can attain temperatures to 325°C, using Dowtherm-A.

Since some vessels had previously been equipped with steam coils or were glass-lined, insertion of heaters into

the vessel or jacket was impractical. Instead, transfer media is heated adjacent to the vessel and circulated by sump-type centrifugal pump.

Perhaps your Chromalox Man, listed at the right, can help you solve some of your heating problems the easy, economical, *electrical* way. Why not give him a call for
Faster heating of water, oils, Dowtherm, Prestone.
Faster melting of grease, asphalt, solder, babbitt.
Faster superheating of steam, compressed air.

4994

CHROMALOX
Electric Heat
INDUSTRIAL • COMMERCIAL • RESIDENTIAL

EDWIN L. WIEGAND COMPANY
7514 Thomas Boulevard • Pittsburgh 8, Pa.

CHROMALOX has a complete line of electric heaters to meet all your liquid processing requirements:





**Call
Chromalox
for the man
with the
Electrical
Answers
to your heating
problems**

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Mohawk 4-6113
Greenwood 3-4477

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BINGHAMTON, N. Y.
R. P. Smith Co., Inc.
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Phone 4-7703

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R. L. Faber & Assoc., Inc.
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Edison 8-6900
New York: Worth 4-2990

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Liberty 2-1941

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Summer 4000

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Amherst 5-3862

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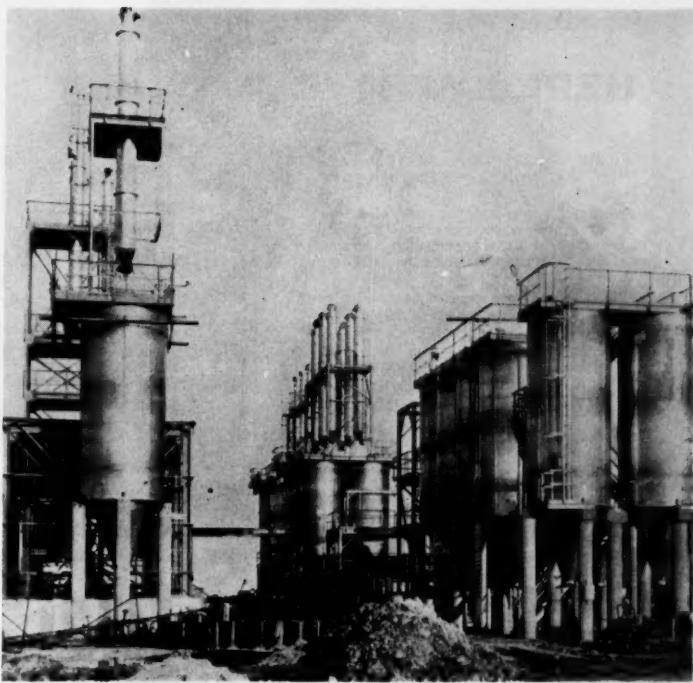
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FIRMS IN THE NEWS

R. A. LABINE

NEW FACILITIES



Add 75 Million Lb./Yr. to Polyethylene Capacity

U. S. Industrial Chemicals is now shipping commercial quantities of high-pressure polyethylene from its new 75-million-lb./yr. plant in Houston, Tex. Plans are already under way to double capacity; expansion is expected to be completed by third quarter of 1960.

California Spray Chemical Corp. will build a \$2-million ammonium nitrate plant at Kennewick, Wash. Calspray awarded Chemical & Industrial Corp. of Cincinnati, Ohio, the contract to build the nitric acid and ammonium nitrate plants.

Seiberling Rubber Co. has begun construction of a 20,000-sq.-ft. expansion of its New-

comerstown, Ohio, Plastics Div. facility. Goal for the next two years is to double present output of laminated plastic products.

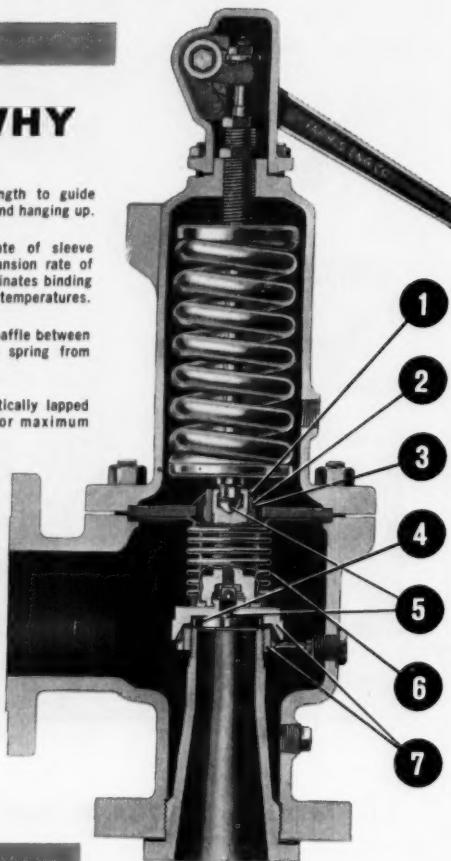
Koppers International, C. A., announces that Industrias Platicas Argentinas Koppers, S. A., in which it has an interest, will build three petrochemical plants costing a total of \$31 million. The 15,000-ton/yr. styrene unit, and ethylene and polyethylene plants will join a polystyrene plant, now on stream near Buenos Aires, Argentina.

Dixon Chemical Industries has started construction of 300,000-ton/yr. sludge-burning

OUTSELLS THEM ALL!

HERE'S WHY

- 1 $2\frac{1}{2}$ to 1 ratio—guide length to guide diameter—prevents galling and hanging up.
- 2 High thermal expansion rate of sleeve guide and low thermal expansion rate of hardened stem retainer eliminates binding and galling even at elevated temperatures.
- 3 Sleeve guide provides solid baffle between body and bonnet, shielding spring from lading fluid.
- 4 Hardened stainless steel optically lapped flat disc—self aligning for maximum tightness.
- 5 Double universal ball joint from stem to disc for self alignment—eliminates effects of spring, temperature and piping distortion.
- 6 Stainless steel "BALAN-SEAL" bellows nullifies effect of back pressure and isolates internal working parts from lading fluid.
- 7 Cone-shaped disc holder directs flow away from guiding surfaces and forms fixed secondary orifice with single blowdown ring control for built-in capacity.



Farris full nozzle Safety-Relief Valves

Simplicity in design, safety in operation... what more can you ask of a Safety-Relief Valve! The patented design features shown in this Farris valve have been *standard* for more than a decade. It's the ideal concept of a trouble-free, safe, safety valve, free from inventory and design change problems since 1945. It's the *preferred design* in full nozzle safety-relief valves for the process industry.



Detailed information for the selection and sizing of all Farris process safety-relief valves is in Catalog FE-118. Sent to you on request.

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FIRMS . . .

sulfuric acid plant in Paulsboro, N. J., to be completed by September. Chemico will build the plant with over-all supervision by Singmaster & Breyer, consultants to Dixon Chemical.

Consolidated Mining & Smelting Co. plans to erect a \$5-million plant in Calgary, Alta., for production of urea at site adjacent to company's present fertilizer plant. Capacity will be over 36,000 tons/yr. when completed in mid-1960.

Union Carbide will build a 12,000-metric-ton/yr. ethylene oxide and derivatives plant in Italy for S.p.A. Celene, jointly owned by Carbide and Societa Edison of Milan. New unit will be located adjacent to Celene's polyethylene plant near Prioli in Sicily; production is slated for mid-1960.

Pittsburgh Coke & Chemical Co. has completed engineering for a major expansion of its activated-carbon-from-coal plant in Pittsburgh. Construction, soon to begin, will be completed late this year.

Tennessee River Pulp & Paper Co. will begin construction this summer on 500-ton kraft and paperboard mill at Counce, Tenn. M. W. Kellogg will build this \$40-million mill to be completed by January, 1961.

Badger Manufacturing Co. will design and engineer a 10,000-metric-ton/yr. phthalic anhydride plant for Aziende Colori Nazionali Affini of Milan, Italy. The fluid-bed catalytic process, being engineered by Badger, will go on stream late this year.

Pacific Vegetable Oil Corp. will build a \$500,000, 8,000-gal./day safflower-oil plant in Culbertson, Mont. Safflower is widely used by the paint and varnish industry as a substitute for linseed oil.

Baugh Chemical Co.'s subsidiary Allegheny Electronic Chemicals Co. has begun production of silicon for semi-

conductor use at its new Bradford, Pa., plant. Allegheny Chemical produces both bulk polycrystalline and single crystal silicon.

Texas Gulf Sulphur Co. announces plans for a \$3-million expansion of its marine shipping facilities on the Neches River, south of Beaumont, Tex. Increased production at its Fannett Dome spurred this expansion. A 3,600-ft.-long, 36-ft.-deep canal will permit 15,000-ton tankers to travel up the river to Texas Gulf's molten and solid bulk sulfur storage area.



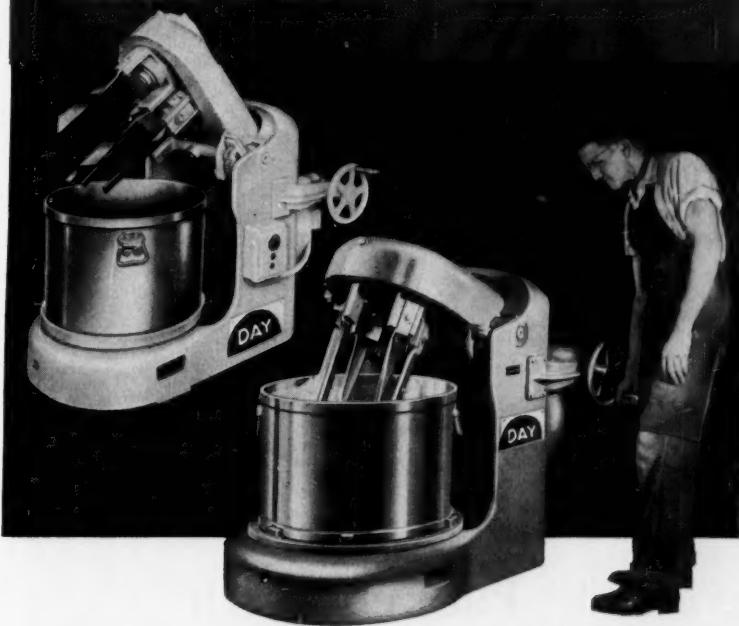
Avondale Marine Ways has opened a new rubber-lining facility at its Avondale, La., plant under an agreement with U.S. Rubber Co. Large rubber-lined pipes above are destined for the U.S. Engineers' new sea-going hopper dredge.

Wyandotte Chemicals has its ethylene oxide-glycol unit back on stream at Baton Rouge, La., after an explosion and fire last November. Company says that "basic manufacturing process (Shell's oxygen-oxidation process) is sound and the plant is a safe one to operate" and that "certain technical improvements" were incorporated into the rebuilt unit.

Wesson Oil & Snowdrift Co. is starting a 20% expansion of its hydrogen plant in Chicago; engineering and procurement will be done by Girdler Construction. High-purity hydrogen, produced by steam reforming of propane,

Check the **PROFIT POINTS** of **DAY**

Gearless PONY MIXERS



1. FAST, UNIFORM BLENDING of all ingredients being mixed. Agitator action insures against "dead spots" and stratification of materials—whether dry mixes, pastes or high viscosity liquids.

2. RUGGED, RIGID, TROUBLE-FREE construction makes DAY the standard of dependability. One piece cast frame assures absolute rigidity. Geared head motor drives agitators and can through roller chain and sprocket.

3. GUARANTEED PRODUCT PROTECTION from grease and oil. No bearings or stuffing boxes in the product zone.

4. QUICK, EASY REMOVAL OF AGITATORS from the batch. Counterbalanced head tilts easily by hand-wheel. Power tilting optional.

5. A MODEL FOR EVERY NEED with single motion or twin motion mixing action, one or two speed motors, in working capacities from 3 to 125 gals.



For full details, call in the Day field engineer in your area or write for Bulletin No. 500.

Mixer shown above, top, is Day Twin Motion Pony Mixer, having twin spindles with counter-rotating, overlapping blades. Shown immediately below is Day Single Motion Mixer. Day hydraulic lift trucks, left, and extra interchangeable cans, will further speed your production.

The J. H. DAY Co.

Division of The Cleveland Automatic Machine Co.

QUALITY MIXING, BLENDING, MILLING AND SIFTING MACHINES SINCE 1887

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New York City will be host to this great international event which will be attended by thousands of the world's leading oil men from over 45 countries.

Packed With Important Benefits for You!

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It's your special opportunity to see, discuss and compare these latest developments for use in oil research, production, refining, transportation... plus nuclear energy applications.

Plan now to attend... and bring your key men with you. Their visit will stimulate fresh thinking and new approaches to many problems—just one idea picked up here will make their trip more than worthwhile.

For advance registration and hotel information write the Exposition at 480 Lexington Avenue, New York 17, N. Y. © 1959



WORLD PETROLEUM CONGRESS EXPOSITION

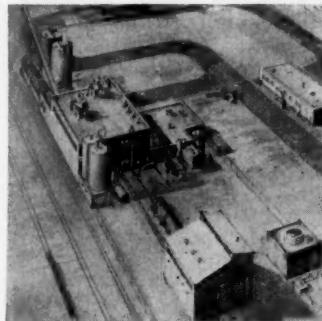
New York Coliseum
June 1-5, 1959

Management: International Exposition Co.

FIRMS . . .

is used in hydrogenating vegetable oils and shortening.

Cyanamid of Canada will spend more than \$1.5 million in equipping its plant at St. Jean, Que., for production of Formica laminated plastics. Firm has already established a Canada-wide sales organization to handle the product.



Cargill, Inc., is building a new soybean processing plant at Norfolk, Va., that will increase by 50 to 60% the processing capacity of the five-state area. The solvent-extraction plant will turn out 10 million gal./yr. oil and 170,000 tons of meal.

Allied Chemical Corp. will install a Cottrell precipitator to remove gypsum dust and other pollutants from exhaust gases at its gypsum plant in Edgewater, N. J. Precipitator will handle 41,500 cu. ft./min. of 300-F. gases from gypsum kettles, milling and combustion operations.

Southwestern Industrial Electronics Co. just opened its new 300,000-sq.-ft. research, development and production facility for electronic instruments. SIE, a division of Dresser Industries, has supplied the petroleum industry with instruments for 14 years.

Peter Kiewit Sons will construct the \$9-million nuclear portion of the Hallam Nuclear Power Facility at Hallam, Neb. Bechtel Corp. is architect-engineer of the 75,000-ekw. power plant.



Hooker Chemical has formed a new Western Div. consisting of firm's plants at Tacoma and Spokane, Wash., Hooker's Canadian subsidiary, and storage facilities at Wilmington, Calif. This is the final step in firm's move to divide its 12 plants into divisions.

Pfaudler Permutit, Inc., has purchased the Ideal Welding Co. of Toronto, Ont., for an undisclosed sum. Move, says Pfaudler Permutit, will provide added coverage of Western Hemisphere markets.

Hercules Powder, Wilmington, Del., has formed a new applications group, called Plastics & Elastomers Div., to conduct product development work on thermoplastic polymers, thermosetting resins, filled and reinforced plastics, and rubber compounding.



OVERSEAS BRIEFS

Imperial Chemical Industries is building Britain's first large-scale plant for manufacturing acrylonitrile in northern England. Production is slated to begin near the end of this year; majority of output will go into synthetic fibers with small amount going into high-impact-strength resins.

Hungary is enlarging its Csepel paper works so that it can supply 100% of the country's needs by 1962. The plant produced 30,000 metric tons of paper and 17,000 metric tons of cellulose in 1958.

Venezuela's Negroven organization has concluded a licensing agreement with United Carbon Co., Charleston, W. Va., for processes to be used in

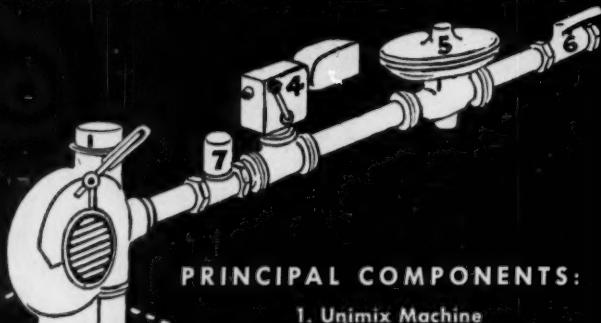
**NEW FROM
KAISER CHEMICALS**

ACTIVE ALUMINAS

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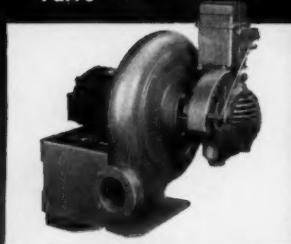
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High efficiency through matched components



PRINCIPAL COMPONENTS:

1. Unimix Machine
- 2 & 3. Line Burner Sections
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New Eclipse Unimix machines maintain constant air-gas ratio by means of easily preset, adjustable, gas orifices. Automatic temperature control is obtained through electric or pneumatic proportioning motor operators.

Eclipse high-velocity air-heating combustion systems are individually job engineered using standard components.

The typical system illustrated has a capacity of 2,000,000 btu/hr with air velocities past the burner assembly in the range of 2000 to 3000 fpm. Recirculating temperatures of 600° pose no problem for standard Eclipse line burners. The superior retention-type Eclipse line burner array permits a uniform firing pattern, resulting in uniform heat distribution at high air velocities.

Systems of either higher or lower capacity can be designed to suit any air-heating requirement.

Eclipse engineers are at your service to assist on any special requirement. Remember, single-source responsibility is your best choice in the long run.

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Eclipse

INDUSTRIAL
COMBUSTION DIVISION

FIRMS . . .

a \$2.4-million carbon black plant to be erected at Moron, Venezuela. Completion is slated for July 1960; capacity will be 20 million lb./yr.

Poland's first sulfuric acid plant burning mined sulfur will go into production by year's end at Thorn in western Poland. Plant, with capacity of 100,000 metric tons/yr., is part of the Thorn phosphate fertilizer complex.

Britain's Central Electricity Generating Board is planning construction of a \$2.8-million research center alongside the Berkeley nuclear power station now under construction. Laboratory will study construction and behavior of nuclear reactors for industrial use.

Czechoslovakia's newest project is a new synthetic rubber plant that will have an annual capacity of 30,000 metric tons after the first half is completed in 1963. Plant will employ Soviet processes.

Imperial Smelting Corp. is planning to start first British commercial production of nuclear-grade beryllium at its zinc plant at Avonmouth; major customer will be the U.K. Atomic Energy Authority. It's estimated that British demand for beryllium may be up to 100 tons/yr. by 1965.

NEW NAMES



Rexall Drug Co. plans to change its name to Rexall Drug & Chemical Co., subject to stockholder approval. Firm anticipates that a major portion of its future growth will be in petrochemicals and allied products.

Aerotech Specialties, Glastonbury, Conn., has changed its name to United Sensor & Control Corp. Among firm's products are thermocouple and pressure probes.

NEW LOCATIONS



American Meter Co.'s sales office serving New England has been moved to 250 Stuart St., Rooms 901-2, Boston 16, Mass.

Fritz W. Glitsch & Sons, manufacturers of fractionation trays and pressure vessels for the petroleum refining and chemical industries, has established a new sales office at 256 Peachtree Blvd., Baton Rouge, La.

International Resistance Co. has moved its Los Angeles sales office into new quarters at 1136 North La Brea, Hollywood, Calif.

Kaiser Aluminum & Chemical Corp. plans to move its general sales office from Chicago to Oakland, Calif., within the next few months. Move will bring together all of Kaiser's policy-making groups under one roof.

Babcock & Wilcox's Tubular Products Div. has relocated its Atlanta district sales office to 464 Peachtree Building, 805 Peachtree St. N.E., Atlanta 8, Ga.



NEW LINES

Jones & Laughlin Steel Corp. is entering the market for electrical steels for the first time, offering a line of carbon electrical steels made in the company's new basic oxygen furnaces.

Tube Turns Div. of Chemetron Corp. has entered the field of flexible piping components. Among major uses for flexible piping units are in certain fluid catalytic processes that need short piping for minimum pressure-drop.

jamesbury Double-Value "Double-Seal" Ball Valves



HIGH PRESSURE Style "H" Valve

(3,000-4,500 pressure range)

In 1/4" thru 2" pipe
and tubing sizes* for:

High Pressure service
High Vacuum service
Handling of hazardous fluids
Cryogenic operations

* Larger sizes on application

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Jamesbury Literature

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CALENDAR

Natural Gasoline Assn. of America,
38th annual meeting, Baker and
Adolphus Hotels.
April 22-24 Dallas, Tex.

**American Institute of Mining, Metal-
lurgical and Petroleum Engineers,**
International Symposium on Phys-
ical Chemistry of Process Metal-
lurgy, Penn Sheraton Hotel.
April 27-30 Pittsburgh, Pa.

**Assn. of Consulting Chemists and
Chemical Engineers,** symposium
and banquet, Shelburne Hotel.
April 28 New York, N. Y.

**13th Annual Power Sources Con-
ference,** Shelburne Hotel.
April 28-30 Atlantic City, N. J.

Chemical Institute of Canada, Rubber
Chemistry Div., annual meet-
ing, Sheraton Brook Hotel.
May 1 Niagara Falls, Ont.

Electrochemical Society, 115th na-
tional meeting, Sheraton Hotel.
May 3-7 Philadelphia, Pa.

**American Society of Mechanical En-
gineers, Maintenance & Plant En-
gineering Division Conference,**
Edgewater Beach Hotel.
May 4-5 Chicago, Ill.

American Institute of Chemists, an-
nual meeting, Hotel Traymore.
May 6-8 Atlantic City, N. J.

**Institution of Chemical Engineers-
Society of Instrument Technology-
British Computer Society,** sym-
posium: Instrumentation and
Computors in Process Develop-
ment and Plant Design, Central
Hall, Westminster.
May 11-13 London, England

**Operations Research Society of
America,** national meeting, Shore-
ham Hotel.
May 14-15 Washington, D. C.

International Petroleum Exposition,
May 14-23 Tulsa, Okla.

**American Institute of Chemical En-
gineers,** national meeting, Hotel
Muehlebach.
May 17-20 Kansas City, Mo.

American Ceramics Society, annual
meeting, Palmer House.
May 17-21 Chicago, Ill.

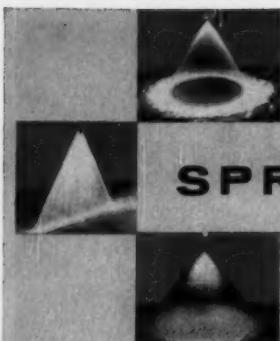
**Chemical Specialties Manufacturers
Assn., Drake Hotel.**
May 18-20 Chicago, Ill.

**Commercial Chemical Development
Assn.,** annual resort meeting, Po-
cono Manor.
May 25-26 Poconos Mts., Pa.

Chemical Institute of Canada, 42nd
annual conference, Nova Scotian
Hotel.
May 25-27 Nova Scotia, N. S.

**American Society for Quality Con-
trol,** annual meeting, Hotel Shera-
ton.
May 25-27 Cleveland, Ohio

**Technical Assn. of the Pulp and
Paper Industry,** 10th Coating Con-
ference, Statler Hotel.
May 25-27 Boston, Mass.



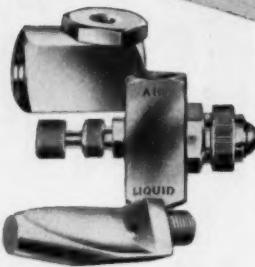
SPRAYING SYSTEMS CO.

SPRAY NOZZLES

products and services
to improve your production

PRODUCTS

Whatever your application might be, Spraying Systems Co. offers spray nozzles to meet your need exactly. Over 12,000 standard nozzle types and capacities . . . to obtain whatever spray characteristics and capacities you desire in spraying, relative to any combination of liquid physical and chemical qualities.



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As a part of its own plant operation, Spraying Systems Co. maintains its own research facilities, for the continuing study of new spray nozzle designs, materials and applications. The many advantages of research are an inherent quality of every Spraying Systems spray nozzle you buy.



TECHNICAL INFORMATION

Complete information on spray nozzle types, capacities and performance characteristics are available in reference catalog form. Data Sheets on hundreds of basic applications are also yours for the asking. You will find Spraying Systems a reliable reference source for any information concerning spray nozzles and their application.

SPRAYING SYSTEMS CO.

3275 RANDOLPH STREET
BELLWOOD, ILLINOIS



For general information . . . Your
inquiry for Catalog 24 is invited.

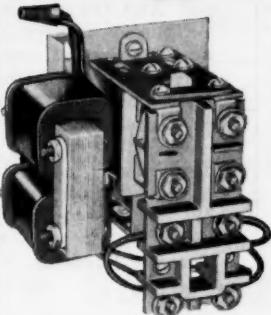
SPRAY NOZZLES FOR VISIBLE, MEASURABLE BETTER PERFORMANCE

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LIQUID LEVEL CONTROLS . . .

give you all these advantages!



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- Standard 2&3 pole units listed by U/L

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*Seriously
speaking . . .*

Semiconductor devices such as transistors, diodes and rectifiers improve the performance and reliability of radios, TV sets, hearing aids, computers and missiles and also make possible many other electronic devices.

Mallinckrodt . . . called in early to develop fine chemicals for the electronics industry . . . provides an extensive line of special-purity TransistAR® chemicals to help manufacturers maintain the extremely low impurity levels necessary for successful production of semiconductor devices.

Electronics is only one of many industries which rely on Mallinckrodt process chemicals, manufactured to strict specifications to meet particular production needs.

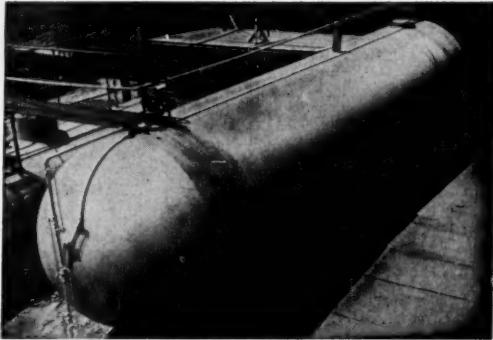
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Experience



- We have been supplying the chemical processing industry with tanks and vessels for chemical storage for three generations. In addition to carbon and stainless steel, we also fabricate and erect tanks, pressure vessels and processing equipment of aluminum and special alloys. . . . Investigate our facilities and take advantage of our 103 years of specialized knowledge and experience. . . . Write for *Tank Talks*.



Elevated Tanks, Pressure Vessels, Chemical and Processing Equipment from Aluminum, Stainless and Carbon Steel, Monel and Other Alloys.

Established 1854

R. D. COLE MANUFACTURING CO.
NEWNAN, GEORGIA

The New
FAIRMONT-built
EASY-FLO
bin device

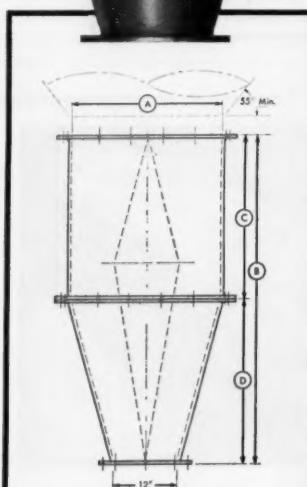
A Gravity Control Tap That Discharges Dry, Semi-Dry or Moist Bulk Solids in Loads up to 7000 Pounds per Minute.

This new **FAIRMONT**-built Easy-Flo Bin Device is designed and engineered to insure control and storage outflow of bulk solids that includes pigments, ores, plastic and metal powders and catalysts, etc., in forms of dusts, prills, pellets, granules, tablets, etc., in dry, semi-dry or in moist condition up to 12 per cent surface moisture.

The new **FAIRMONT**-built Easy-Flo Device regulates outflow by gravity . . . controls forces and conditions acting on material unloaded from the bins . . . speeds it up to 7000 pounds per minute without stoppage!

A low pressure discharge outlet eliminates costly gates and similar cut-off equipment. The double-cone stainless steel gravity element automatically maintains the material in an unpacked state once it passes from the storage bin into the Device.

Ruggedly constructed of non-movable parts, the **FAIRMONT**-built Easy-Flo Bin Device is precision fitted and durably bolted to eliminate vibration and excessive wear, and to cut out maintenance and repair. Three standard sizes for permanent installation are available.



SIZE	A	B	C	D
1	24"	50"	27 1/2"	22 1/2"
2	28"	60"	30"	30"
3	36"	88"	43 1/4"	44 1/4"

NOTE: It may be necessary to install a transition hopper with the Easy-Flo Bin Device.

When requesting additional information include layout and details of existing equipment, capacity of bin (cu. ft.), and size, screen analysis and surface moisture of material to be handled.

FAIRMONT MACHINERY COMPANY

FAIRMONT, WEST VIRGINIA

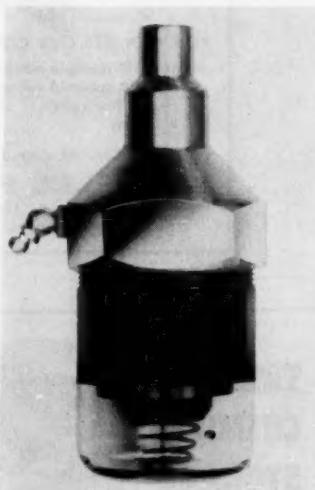
ENGINEERS • DESIGNERS • FABRICATORS and CONSTRUCTORS

NEW EQUIPMENT . . .

(Continued from p. 104)

sor's intercooler draws only 560 gph. of 60 F. cooling water—less than half the amount usually required by compressors with comparable air output. And, the new unit features a unique lubricating system that requires oil replenishment only once every three weeks, even when operated on a three-shift basis.

Available for any number of applications, the ER-6 can be coupled to synchronous motors or directly coupled to standard induction motors.—Atlas Copco Eastern, Paramus, N. J. 104D

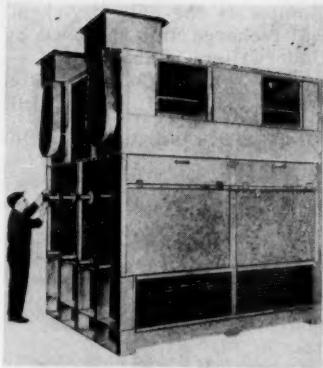


Automatic Grease Cup

Lubricates plain or anti-friction bearings.

Automatic self-feeding lubrication with visible control is the function of the new Lubrimatic grease cup. This product features a large, 4-oz. lubricant reservoir; vented plastic cylinder for easy view of lubricant supply; spring and weighted plunger to feed grease to bearing with predetermined pressure, and a down-pressure fitting that eliminates possibility of cup breakage in the process of filling.

According to the manufacturer, Lubrimatic grease cups save 75% or more of lubrication labor costs, and eliminate hit-or-miss greasing practices.—Lubriquipment Engineers, Inc., Ft. Worth, Tex. 218A



Air-Cooled Exchangers

Two new models for high-capacity cooling.

A new line of air-cooled heat exchangers, both evaporative and dry-coil type, are available in capacities ranging from 100,000 Btu./hr. to 10,000,000 Btu./hr. Cooling coils come in ferrous and nonferrous construction; cleanable coils are optional. Automatic controls provide temperature control.—Imeco Inc., Chicago, Ill. 219A

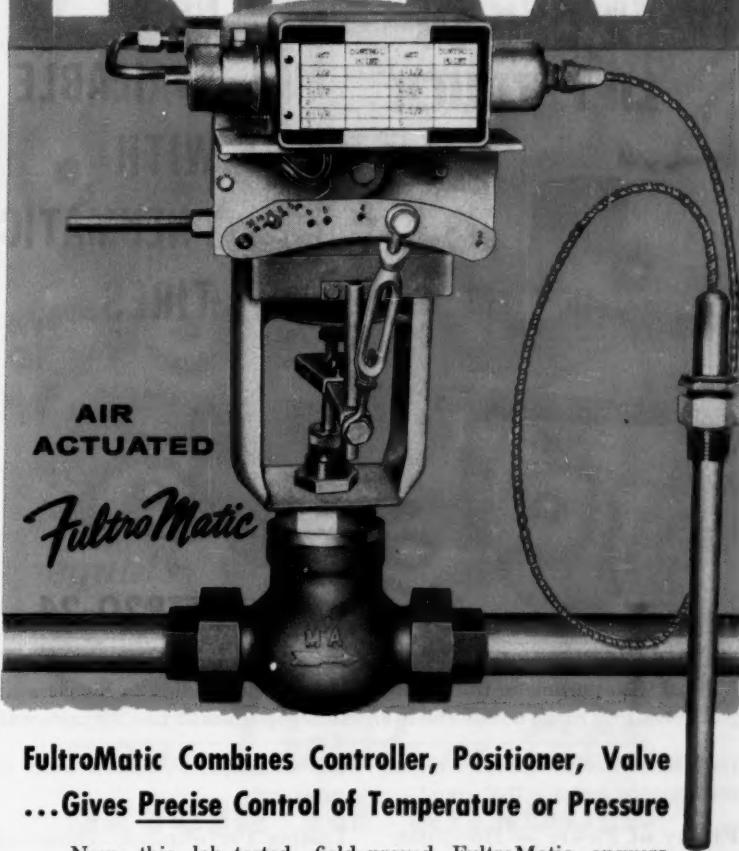


Fire Extinguisher

Designed to occupy a minimum amount of space.

Called the Monitor, a new multipurpose spherical fire extinguisher has a rated effectiveness equal to eight 1-qt. carbon tetrachloride extinguishers. The 2½-lb. dry-chemical cartridge remains fully charged indefinitely; after use, the spent cartridge can be instantly replaced. According to the manufacturer,

3-in-1 Controller at One-Half the Cost!



FultroMatic Combines Controller, Positioner, Valve ...Gives Precise Control of Temperature or Pressure

Now, this lab-tested, field-proved FultroMatic answers today's precise control requirements with multiple features never before available in one unit . . . at about half the cost of two- and three-unit systems!

- ♦ Improved accuracy with smaller, faster-responding element.
- ♦ Positive valve positioning by feedback action; no overshoot.
- ♦ Adjustable proportional band easily changed on the job.
- ♦ Simplified settings with knob, indicator, arbitrary scale.
- ♦ Field reversibility: control action quickly changeable.
- ♦ Easy to install: place valve in position, mount bulb, connect air.
- ♦ Low maintenance: rugged design for trouble-free service.

FOR COMPLETE FULTROMATIC SPECIFICATIONS,
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Robertshaw-Fulton

CONTROLS COMPANY

FULTON SYLPHON DIVISION • Knoxville 1, Tennessee

New

2,000-LB LIFT TRUCK



Allis-Chalmers FTP20-24

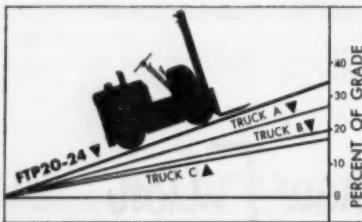
"Hefty," the New Allis-Chalmers FT-20 lift truck, is now available as Model FTP-20 with pneumatic tires. Now "Hefty" is outstanding in his class on yard work, over rough terrain and in areas where pneumatic tires are preferred.

Look how "Hefty" measures up on performance features that count:

Plenty of Power — Heavy-duty industrial engine has 35 hp, 97 ft-lb of torque — most available in a truck this size.

Easily Maneuverable — makes right angle turns in aisles as narrow as 83½ in., plus load.

Stable, climbs 34% grade with load — further evidence of power, torque



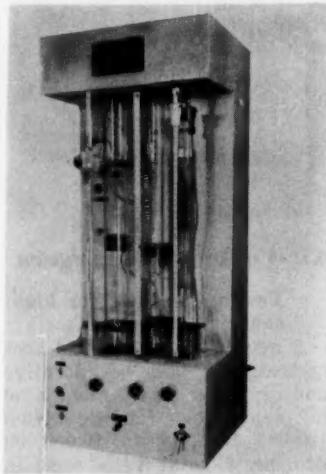
Now "HEFTY" is on air

**NOW
AVAILABLE
WITH
PNEUMATIC
TIRES**

NEW EQUIPMENT . . .

Monitor is the only dry-chemical recharge unit approved by Underwriters Laboratories. — **Ansul Chemical Co., Marinette, Wis.**

219B

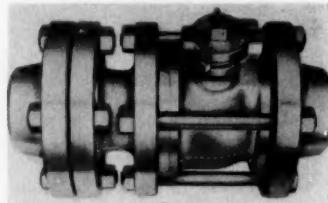


Flow Rate Calibrator

For small volumetric flow devices. High accuracy.

Elimination of vapor pressure, gas and liquid solubility factors, provisions for hermetic sealing and simple operation are among the claimed advantages of Model 1050 volumetric flow rate calibrator. Developed for calibration of small flow devices, the unit offers accuracies within 0.2%. In operation, a volume of fluid is accurately measured and automatically timed as it passes through the device being calibrated. — **Brooks Rotameter Co., Lansdale, Pa.**

220A



Flange Ball Valve

Lowers costs for inventory parts. For many fluids.

Econ-O-Miser flange ball valves serve as either 150-lb. or 300-lb. valves where conditions

BH-107

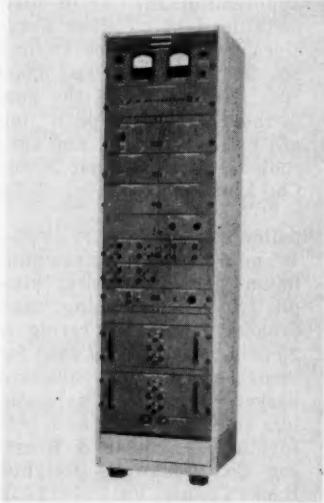


ALLIS-CHALMERS

need not be answered by ASA dimensions. However, should ASA dimensions be required, addition of an appropriate spacer converts the valve into either a 150-lb. or a 300-lb. ASA valve. The manufacturer estimates that savings in inventory parts alone, by shifting to this new design, can be substantial for many users.

Because of the various combinations of seats, O-rings and body materials available, the company feels that this new unit will accommodate almost all media within the pressure-temperature limitations of the sealing materials.—Worcester Valve Co., Inc., Worcester, Mass.

220B



Linkage Systems

Couples analog computers with digital machines.

According to the manufacturer, a new family of high-reliability analog-digital computer linkage systems can effectively couple the speed of an analog computer, which simulates an industrial or experimental process and delivers a graphic result, with the digital computer, which presents its computation in numerical form. Advantages over previous systems include significant reductions in cost, size and complexity.

Shown above is one model that provides 20 analog-to-digital and 10 digital-to-analog

The Accepted Standard in
Package Type Plants
producing
OXYGEN and NITROGEN
Simultaneously

plus

a new package type
Refrigeration Unit

equals

a new STANDARD

now Liquid or GAS
OXYGEN and NITROGEN
simultaneously

FLEXIBILITY of operation, providing ANY COMBINATION of products, liquid or high pressure gas PLUS simultaneous production of BOTH oxygen and nitrogen delivers maximum yield of combined products at minimum cost of operation with little operator's attention. Packaged design requires minimum of installation cost and space.

This most modern and efficient design from Independent combines the best features of the earlier two-product package plants pioneered by Independent with the latest concepts of external refrigeration. Type illustrated in 1500 to 5500 cu. ft. per hour capacities. Other types in larger and smaller sizes. Pure argon available on larger sizes.

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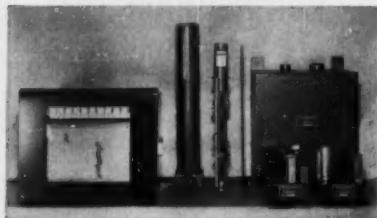
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RADIONIC level indicator

for determination of liquid or solid level within a closed vessel using nuclear radiation. Will provide positive ON-OFF type indication or control of material level within a vessel or control interface between two materials. Mounted externally. Extreme pressures and temperatures do not affect operation.

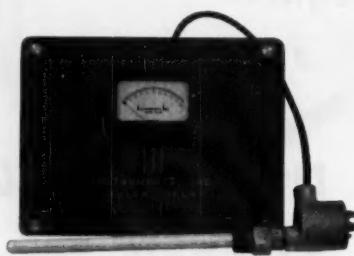


GAGETRON® level control

for level, specific gravity and interface measurement and control, using nuclear radiation. Provides a permanent, efficient control and measurement under severe operating conditions in process vessels and piping. GAGETRON will gage liquid levels continuously or control liquid levels at predetermined point. Mounted internally or externally.

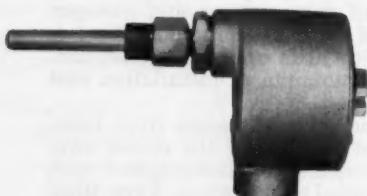
ELECTR-O-LEVEL

an electronic capacitance measuring instrument providing a continuous reading level indicator either locally or remote. For level measurement and control of liquids, solids, viscous fluids, acids and granular materials. Mounted internally. More economical unit for use where extreme accuracy is not required.



ELECTR-O-PROBE®

A capacitance operated super-sensitive electronic relay. Detects liquid levels, solid levels, liquid-liquid interface or foam-liquid interface. Model shown features ease of installation, unitized construction and explosion proof design.



MODEL
B-06

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PIONEERS IN LEVEL MEASUREMENT AND CONTROL INSTRUMENTATION

NEW EQUIPMENT . . .

information channels.

Each of these channels can make more than 400 conversions/sec. with a conversion accuracy of $\pm 0.05\%$. Although intended primarily for linking analog and digital computer facilities, these versatile links may find use in process control and other on-line digital computer applications.—Electronic Associates, Inc., Long Branch, N. J. 221A

BRIEFS

Electric motor for use in non-explosive atmospheres containing excessive moisture or abnormal quantities of dirt, metallic dust or other abrasives, comes in sizes from 1 hp., 900 rpm. to 40 hp., 3,600 rpm. All motors of the new re-rated NEMA Type E line are totally enclosed and fan-cooled.—Lima Electric Motor Co., Lima, Ohio. 222A

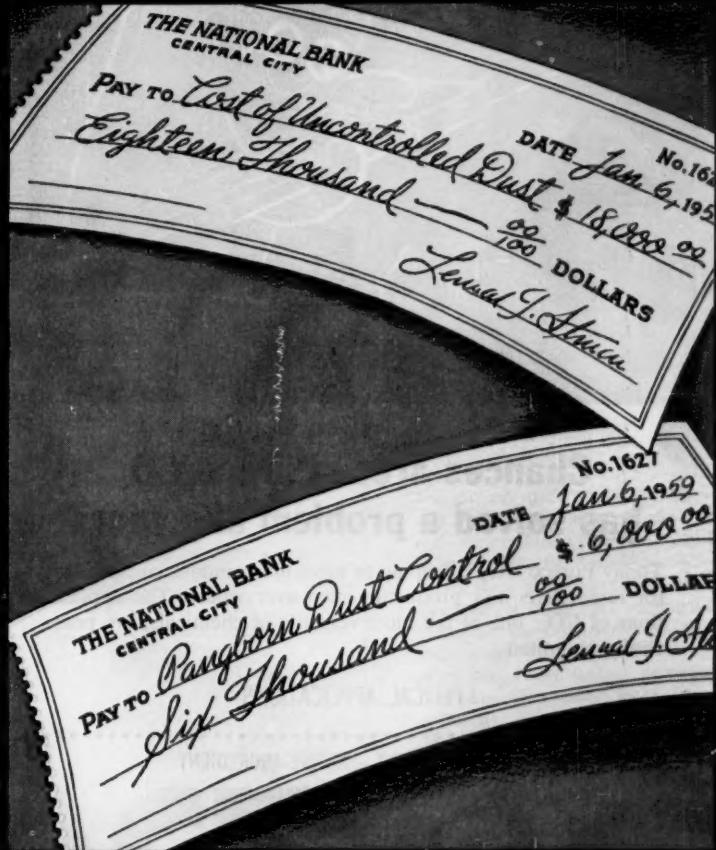
Pipeline strainers, in 2-, 2½-, 3-, 4- and 6-in. sizes feature minimum flow resistance, simplicity, quick-cleaning, and economy. Pressure rating is 25 psig.; cast iron is used for bodies and covers. Standard basket construction is stainless steel plate with $\frac{1}{8}$ -in. perforations.—Schutte & Koerting Co., Cornwells Heights, Bucks County, Pa. 222B

Acid bottles and jars of polyethylene are offered from stock mold in 1-gal. sizes. Bottle opening is 38 mm. and jar opening is 100 mm.—Air-Formed Products Corp., Nashua, N. H. 222C

Check valves designed for gas services to 10,000 psi. are offered for high-pressure tubing and fittings in sizes $\frac{1}{4}$ through 1 in. and for $\frac{1}{2}$ - to 1-in. pipe. Temperature range depends upon composition of seat and seal.—Republic Mfg. Co., Cleveland, Ohio. 222D

Pumps requiring resistance to hot corrosives at temperatures up to 300 F. are made from zirconium alloy contain-

WHICH CHECK WOULD YOU RATHER WRITE?



ing 2.5% hafnium. Price is claimed to be approximately in the same range as pumps made from other special metals. Gears and bearings utilize Teflon as a material of construction.—Eco Engineering Co., Newark, N. J. 222E

Film badge service features continuous cumulative dosage reports for each subscriber plus 24-hr. exposure reports on request. The plastic clip-on badge holds six filters and two lead shields.—Atomic Film Badge Corp., Bellerose, N. Y. 223A

Liquid level controls for pressure ranges from 30 in. vacuum to 100 psi. can actuate a combination of electrical components to perform several different control functions. Visual and audible warnings available.—Petrometer Corp., Long Island City, N. Y. 223B

Flexible rubber impellers for self-priming pumps offer service life up to 1½ times longer than standard impellers. Operating range is 40 to 175 F.—Pacific Moulded Products Co., Los Angeles, Calif. 223C

Submersible pump powered by ½-hp. motor has maximum capacity of 800 gph. Starting switches and capacitors are installed away from pump in a control panel. Motor is enclosed in stainless steel shell.—The Deming Co., Salem, Ohio. 223D

Pressure-reducing valves are suitable for initial pressures up to 250 psi. at 450 F. and 300 psi. at 200 F. A threaded cap allows quick interchange of adjusting springs for different requirements.—The Clark Mfg. Co., Cleveland, Ohio. 223E

Vibration Tamers minimize costly failure due to excessive vibration in piping systems. Coming in sizes from ½ through 12 in., the new units are rated up to 15,000 psi. working pressure and

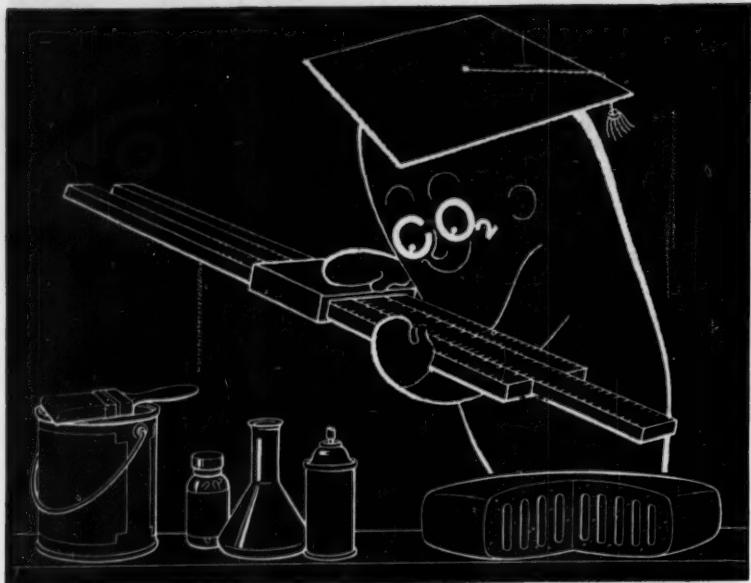
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See for yourself—add up the cost of your lost salvageable material, housekeeping expenses, excess machine wear, intangibles such as community and employee goodwill. Whether your total is moderate or high, Pangborn Dust Control will cost you less than uncontrolled dust.

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If any of the above applications suggest related uses in your processing methods, we would be pleased to discuss them with you. Our wide technical experience in applying CO₂ in its solid (DRY-ICE), gaseous and liquid forms, to industrial problems is available to help you. Call your Pure Carbonic Representative today.



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EQUIPMENT . . .

1,500 F.—The Allied Metal Hose Co., Long Island City, N. Y. 223F

Check valves featuring all-fluorocarbon construction on fluid surfaces are said to be impervious to almost every liquid except molten sodium. Offered in burst-pressure ratings to 1,000 psi., they are recommended for severely corrosive service when valve failures due to ball stickage are a problem. Sizes are $\frac{1}{4}$, $\frac{1}{2}$ and 1 in.—Keystone Engineering, Houston, Tex. 224A

Fine-mesh wire cloth is available in Monel and stainless steel. Sizes cover the span from 120 to 400 mesh.—Michigan Wire Cloth Co., Detroit, Mich. 224B

Multiconductor cable for 6 to 56 pairs of thermocouple conductors is claimed to be much easier to handle and less expensive to install than individual pairs of thermocouple extension wires. Outer polyvinyl chloride jacket resists moisture, abrasion, heat and chemical action.—Thermo Electric Co., Inc., Saddle Brook, N. J. 224C

Equipment Cost Indexes . . .

	Sept. 1958	Dec. 1958
Industry		
Avg. of all	230.9	231.3
Process Industries		
Cement mfg.	223.3	223.7
Chemical	232.3	232.7
Clay products	217.0	217.4
Glass mfg.	219.3	219.7
Paint mfg.	222.8	223.1
Paper mfg.	223.8	224.2
Petroleum ind.	227.5	227.8
Rubber ind.	230.3	230.6
Process ind. avg.	228.6	228.8
Related Industries		
Elec. power equip.	236.0	236.4
Mining, milling	233.7	234.1
Refrigerating	260.3	260.6
Steam power	218.1	218.4

Compiled quarterly by Marshall and Stevens, Inc. of Ill., Chicago, for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124-6 for method of obtaining index numbers; Feb. 23, 1959, pp. 149-50 for annual averages since 1913.

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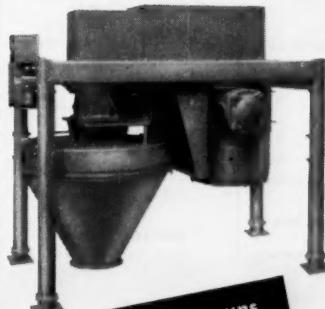
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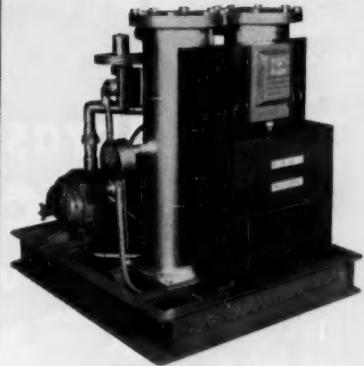
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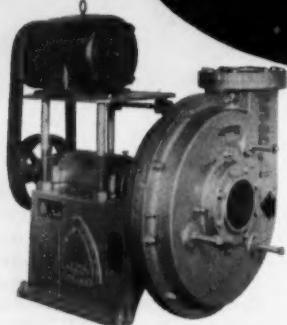
If your particular application calls for recirculating models, which take in only enough fresh gas to compensate for loss through leakage, they are also available. Whether your drying needs concern air or other gases . . . there's a DYNADRYER to meet your specifications.



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TECHNICAL

An Oil Panorama

PETROLEUM—PREHISTORIC TO PETROCHEMICALS. By G. A. Purdy. McGraw-Hill Book Co., Toronto; New York. 492 pages. \$15.

Here, indeed, is an impressive panoramic view of oil, the entity and the industry. Needless to say, in 465 pages of text it's impossible to probe very deeply into any one facet of such a broad topic. Nevertheless, Author Purdy has given us a book interesting to read and rewarding for the effort.

Too bad that the nonpetroleum reader, who will find the book most valuable, might not include the book in his library because of the high price. Petroleum or refinery engineers won't learn an awful lot from the book, except possibly from the chapters on History of Petroleum and Fuels. But the general reader, even the nonpetroleum engineer, will find valuable knowledge presented in an attractive and readable style.

One word of caution: The volume is by no means a text or sourcebook; engineers, economists, market researchers will find little to help them in their work. Properties of crudes, economic data and trends refer chiefly to Canada. (Government jet-fuel specifications, for example, are those of the Canadian Government.) And, as the author admits, the history of oil in Canada reads much like the history of Imperial Oil Limited. ►Thorough and Clear—Except in isolated instances, the book is remarkably thorough and up to date. Refining chapters, for instance, include short descriptions of some of the more recent reforming and treating processes.

Subheadings arrange topics in such a way that the refining engineer can omit entire chapters on refinery operations. Yet the general reader can learn much of how a refinery operates and is introduced painlessly to the spectrum of processes from distillation to treating. Almost

BOOKSHELF

J. B. BACON

without knowing it, he will meet and understand such terms as reformate, reflux, rerun, stabilization, lean oil and (for Canadians, at least) fat oil.

The book is full of informative diagrams and pictures, and the wide margins provide an ideal place to jot notes or doodles.

—JBB

BRIEFLY NOTED

BIBLIOGRAPHY ON INDUSTRIAL RADIOLOGY, 1956-1958. (7th Supplement to INDUSTRIAL RADIOLOGY, John Wiley & Sons.) 27 pp. By Herbert R. Isenburger, St. John X-Ray Laboratory, Califon, N. J. \$4. Updates technical bibliography, reflects attention placed on safety precautions since the advent of radioisotopes.

CHEMICAL RESISTANCE AND THERMAL STABILITY OF FLUOROCARBON ELASTOMER. 23 pp. By A. Wilson, C. B. Griffiths and J. C. Monteroso, U. S. Army. Order PB 131942 from Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. 75¢. Reports Army studies dealing with effects of fuels, oils, acids and heat on a copolymer of vinylidene fluoride and perfluoropropene.

GAS-COOLED POWER REACTORS. 376 pp. Oak Ridge National Laboratory, U. S. Atomic Energy Commission. Order from Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. \$3.50. Consists of 22 papers given at joint Government-industry meeting at Oak Ridge, Oct. 21-22, 1958; covers such topics as design, optimization, components, hazards and fueling of gas-cooled reactors.

INDUSTRIAL ENVIRONMENT — ITS EVALUATION AND CONTROL. 364 pp. Issued by Public Health Service. Order from Superintendent of Documents, Government Printing Office, Washington 25, D. C. \$2.75. Syllabus of short courses offered for industrial hygiene engineers and chemists at Occupational Health Field Headquarters of the Service at Cincinnati, Ohio; incorporates reference materials, lecture outlines and laboratory exercises used in the course.

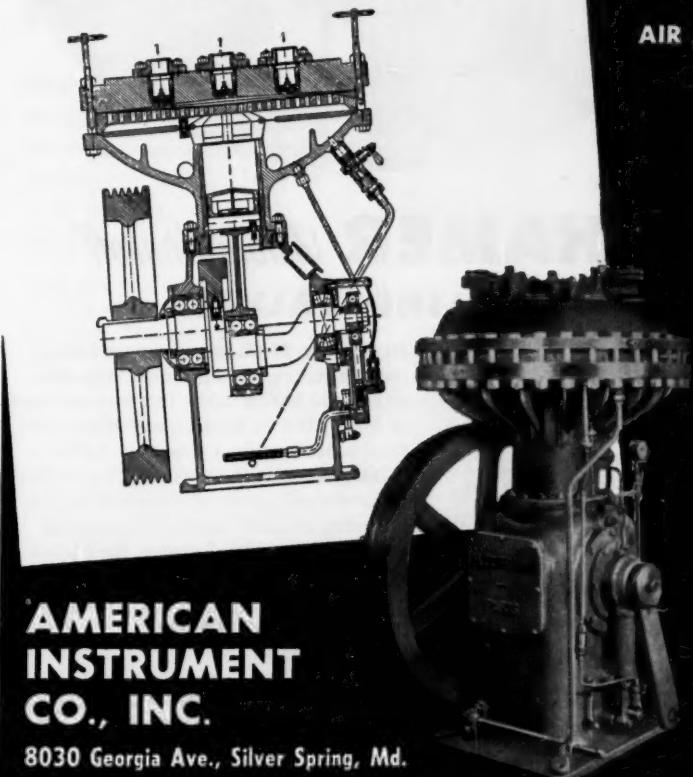
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LETTERS:

More on Tax Deductions

Sir:

I am writing for further information in reference to your article, "How Engineers Can Save on Income Tax" (Feb. 23, 1959, pp. 156-160), especially the reference to use of an office-at-home.

I have discussed this matter with the Internal Revenue people in Chicago. They inform me that they know of no new regulations covering this situation. They state that, as far as they know, such deductions can be made only by a consulting engineer, and not by one working on a salary.

Your article is very interesting. I suppose it would apply also to a chemist, and for that reason we are very anxious to have the situation clarified as soon as possible in order to take advantage of this year's savings.

C. E. GRAHAM
Wilson Laboratories
Chicago, Ill.

Sir:

The article entitled "How Engineers Can Save on Income Tax" contained information on deduction of expenses for maintaining a separate room for purpose of doing your employer's work at home. Can you give me a tax code, regulation or case citation which provides the authoritative support for this information?

C. G. DIBBLE
Pittsburgh, Pa.

► We received both these letters early in March and, of course, answered them individually right away so that Messrs. Graham and Dibble could prepare their tax returns accordingly. Although the April 15 deadline is now past, the following explanation may be of some value to other tax-conscious readers:

Before we published the article, we checked it with the tax department of our own company, McGraw-Hill Publishing Co. They informed us that we had correctly stated the facts. Since publication we have asked the J. K. Lasser organization (retained by McGraw-Hill for tax

PRO & CON

C. H. CHILTON

and auditing purposes) to review our article. They affirm that it is completely correct.

To the best of our knowledge, the rulings which we reported were handed down by the Rulings Division of the Internal Revenue Service in Washington (we are trying to get specific ruling numbers). However, a weakness of the whole IRS structure is that each district seems to be unaware of what is going on in any other district or even ignorant of decisions which are reached in Washington. We have also discovered that individual employees of IRS operate pretty much on their own, so that two examiners in the same district office can reach opposite decisions on the same question.—ED.

Who Made First Move?

Sir:

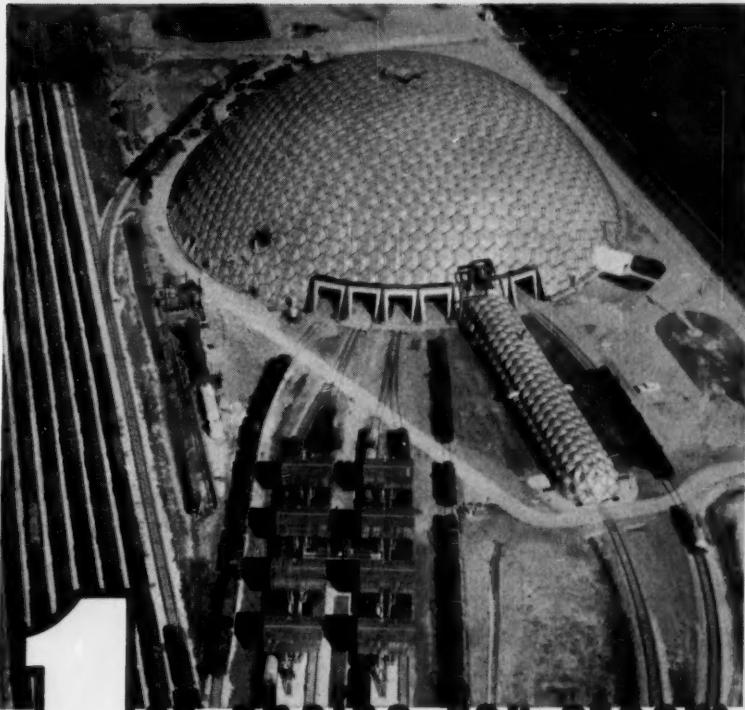
In your February 23 issue (p. 57) you state, "In the case of Monsanto vs. Central Farmers Fertilizer Co., a recent move by Monsanto to settle out of court got nowhere." You then go on to discuss an alleged proposal by Monsanto for settling the case.

Your good journal couldn't be more inaccurate in its statement. As a matter of fact, Monsanto at no time has initiated efforts to settle its case against Central Farmers. The information set forth in the article and the obvious tone of it clearly indicate that your reporter obtained certain information from Central Farmers and the editor fell for it.

EDWIN J. PUTZELL, JR.
Monsanto Chemical Co.
St. Louis, Mo.

► Mr. Putzell does not deny the principal substance of our story, namely, that Monsanto and Central Farmers got together and discussed possible terms for an out-of-court settlement of their dispute over the alleged use of Monsanto trade secrets in Central Farmers' new elemental phosphorus plant.

Only point at issue is who initiated these talks, and here we have conflicting claims. In a case like this, it is possible that each party honestly believes that the other made the first move.—ED.



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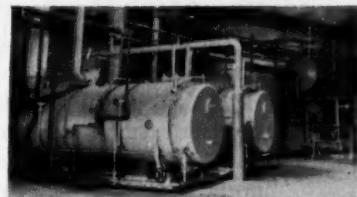
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More on Viscosity Data

Sir:

I wish to make these comments concerning my March 9 article (pp. 151-152) on estimating the viscosities of liquid mixtures:

In Eq. (32), $\log \mu_{lm}$ should be just μ_{lm} . In the same equation, ϕ denotes volume fraction, not fluidity.

In the "purported useful range" for Eq. (41), a should be a superscript, referring to the footnote below the table.

Finally, near the bottom of the first column on page 152, "Ref. 91" should follow "Olney and Carlson."

W. R. GAMBILL

Oak Ridge National Laboratory
Oak Ridge, Tenn.

Don't Abuse Cylinders

Sir:

We note in your February 23 issue (p. 154) a Plant Notebook item entitled "Easy Weigher for Your Chlorine Cylinders." This article suggests the use of a weighing device which lifts cylinders by means of a yoke under the cylinder cap or the connection.

For many years, in our Chlorine Manual, we have advised against any practice which suspends cylinders by the cap or by the outlet valve. This recommendation was made because neither the valve nor the cap is designed for this purpose; accidents have resulted from such practices.

All safe means of lifting cylinders are based on supporting the cylinder from underneath. Special carriers or supports can be designed if large numbers of cylinders are to be handled.

ROBERT L. MITCHELL, JR.
Chlorine Institute
New York, N. Y.

More on Nitrogen Oxides

Sir:

I would like to point out that Fig. 1 in my article, "Design Data for Oxides of Nitrogen" (*Chem. Eng.*, Feb. 23, 1959, pp. 139-142), can be used any time the partial pressure of equivalent NO_x is 1.0 atm. or less. Instead

of reading the curves for % equivalent NO_x, read them for partial pressure of equivalent NO_x.

For example, at a given temperature, the fraction NO_x polymerized would be the same for: 10% NO_x at 1 atm., 5% NO_x at 2 atm., 2% NO_x at 5 atm., 1% NO_x at 10 atm., etc. The fraction NO_x polymerized in each of these cases would be read from the 10% equivalent NO_x curve from Fig. 1, and the partial pressure is 0.1 atm. for each example.

E. D. ERMENC
Food Machinery & Chemical
Corp.
Princeton, N. J.

Cost Indexes Clarified

Sir:

I would like to take issue with and possibly get a clarification of several statements by Cecil H. Chilton in your January 12 issue (pp. 131-132) with regard to the Marshall & Stevens equipment cost indexes.

I have spent quite some time studying the article by the late R. W. Stevens in the November 1947 issue of *Chemical Engineering* (pp. 124-126) and have come to the conclusion that the Marshall & Stevens indexes are as good as any available for construction costs—at least for the petroleum industry, in which our company is most interested.

For instance, the makeup given by Mr. Stevens for the petroleum industry equipment cost index is as follows:

Process machinery	25%
Tankage	24
Pipe and fittings	12
Installation labor	19
Power equipment	12
Maintenance equipment ...	2
Office equipment	6

Obviously, this distribution applies to the industry or a plant as a whole and not to any one processing unit; furthermore, certain specific items are excluded: plant buildings, land (right-of-way) and major transportation facilities, such as railroad cars and licensed motor vehicles used outside the plant. Even considering these differences, I believe that the distribution given above will be a reasonably close approximation to



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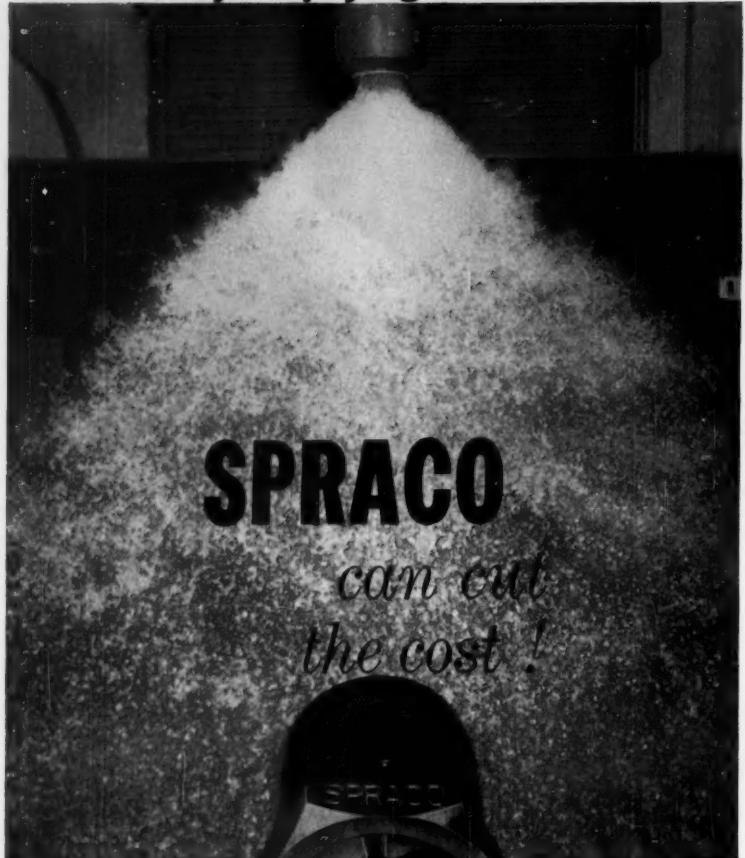
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any "normal" type of processing unit.

One can assume that the total 100% applies to total in-place plant value or job cost (except for the items mentioned above), including engineering and other indirect costs. Assuming this, I do not agree with Mr. Chilton that the 19% for installation labor is a "modest amount"; it could better be called "construction labor" and include all labor involved at the plant construction—not only setting of pumps, compressors, vessels, etc., but also "installation" of foundations, structural steel, instruments, etc. Certainly 19% is too high as a general rule for the labor of installing such equipment as pumps, vessels and ex-changers.

I believe there is a widespread misconception that the Marshall & Stevens indexes apply only to equipment, or "installed equipment," as we have come to define it. The way I interpret information in the Stevens article is that "equipment" is meant to include all "material" costs going into a plant. If I am wrong in this interpretation I would be glad to receive clarification and correction.

I agree with Mr. Chilton that the *Engineering News-Record* indexes are virtually useless for process plant construction. I also agree that we could use a really good index for process plant construction—one that reflects actual conditions and is not made up a certain way merely for convenience in preparing and maintaining. This would cost money, of course.

WARREN O. CARLSON
Cost Engineer
C. W. Nofsinger Co.
Kansas City, Mo.

Sir:

I am writing in reply to your request for clarification of the points brought up in Mr. Carlson's letter.

As Mr. Stevens stated in his 1947 article, the Marshall & Stevens equipment cost indexes are not obtained by pricing specific pieces of equipment periodically, but are primarily determined by average changes in total plant costs based on de-

tailed appraisals and revisions. They are supplemented by studies of specific pieces of equipment and adjusted by the influence of general equipment-business indicators.

In general, Mr. Chilton's recent article was correct in that the index for a complete plant applies to the installed equipment only and not to building construction. However, items such as foundations for the equipment, power wiring to the individual pieces of equipment and installation labor are all included as part of the equipment cost in an appraisal and, as such, do influence the index trend. In some of the equipment categories, the cost of the installation and the construction required for the installation is almost negligible, while in others, such as a petroleum refinery, the amount is a fairly substantial percentage.

Our indexes are not computed by a formal, statistically rigorous method and, as such, cannot be defined as fitting exactly any individual installation. As pointed out in the Chilton article and seconded by Mr. Carlson, there is a need for cost indexes which are designed to fit more-specific plants with enough detail to properly consider and weigh all the major items which contribute to the total cost. We have made some special studies and developed indexes to apply to specific properties, but none of them has been for processing plants.

FRANK C. SWIFT
Publications Manager
Marshall & Stevens Co.
Los Angeles, Calif.

►The important thing in working with cost indexes, as with any other engineering tool, is to know their origins and limitations. As a publisher of the Marshall & Stevens equipment cost indexes, it is our responsibility to point out their origins and limitations.

On the other hand, it is gratifying to learn that Mr. Carlson finds the M&S indexes applicable to total costs of refinery processing units. Perhaps this is because, as shown in our most recent review of indexes (Feb. 23, 1959, pp. 149-150), the M&S equipment cost index and the Austin industrial building cost index have moved together quite closely for the past ten years or so.—ED.



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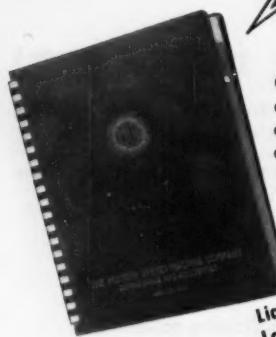
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- 67l—High voltage air break starter

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- 6-7a—Aluminum alloys resistance
- 6-7b—Aluminum alloy heat exchangers
- 6-7c—Aluminum heat exchanger tubes
- 6-7d—Applications of aluminum
- 6-7e—Aluminum alloys for high purity water
- 6-7f—Aluminum alloys resistance to fresh water
- 6-7g—Designing to prevent corrosion
- 59a—Glass bottle holder carrier
- 59b—Waste liquids disposal bottle
- 59c—Tilt-type safety cans
- 59d—Safety drum pump
- 59e—Space saving safety can
- 59f—Safety drum vent for end-bungs
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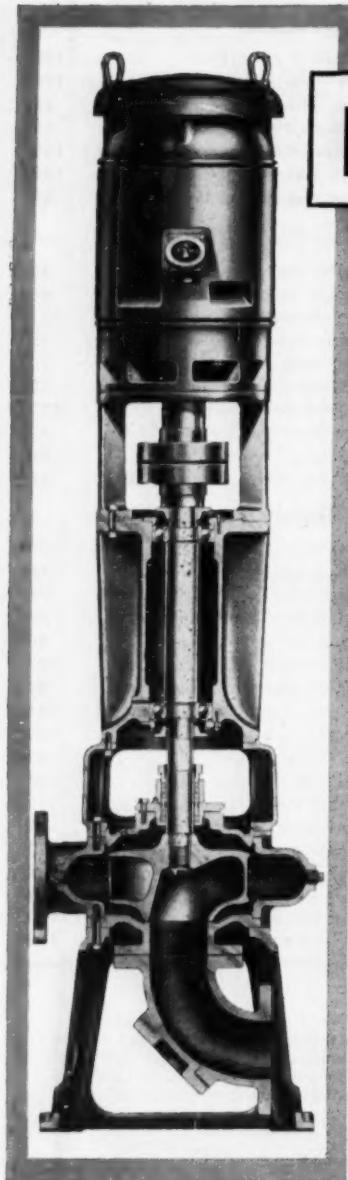
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Flow Formulas. By Maxey Brooke.
CE Flow File (50¢) 112

*Don't forget to ask for your free copy of this issue's reprint feature (p. 188).

For higher pumping efficiency of solids in suspension!



NEW

Fairbanks-Morse 5440A Non-Clog Pumps

Ideal for pumping unscreened liquids with large solids in suspension

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TECHNICAL

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Chemicals

Activated Carbon . . . Booklet describes the types & various applications of activated carbons, in both liquid & vapor phase adsorption. Available now.

127 *Pittsburgh Coke & Chem. Co.

Activated Charcoal . . . acts as a molecular sponge, purifies air, gases, liquids—recovers solvents—removes odors & impurities, etc. Write for Bulletin J-103.

R252 *Barnebey-Cheney

Adhesive . . . 2 p. bulletin 860 describes a new refractory Thermastic Super, termed a Mastic Cement. Recommendations for sealing water-wall boiler tube faces.

238A J. H. France Refractories

Aluminas . . . Services or specifications on any alumina products are available. A copy of a new technical brochure on Aluminas is offered. Send for your copy.

213 *Kaiser Aluminum & Chemicals

Ammonium Bicarbonate . . . Tech. Report 401A outlines how ammonium bicarbonate improves hydrogen peroxide bleaching. Gives details on bleaching solution, etc.

238B Henry Bower Chem. Mfg. Co.

Bacterial Inhibitor . . . for cutting oil emulsions & coolants. Material is combination of bacteriocides thiomerosal & sodium ophenylphenate.

No. 1460

33-34e *U. S. Industrial Chem. Co.

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85 *Enjay Company, Inc.

Butyl Rubber . . . 12 p. catalog pictures a comprehensive listing of application. Charts & graphs show weather and sunlight resistance, chemical & solvent resistance, etc.

238C Enjay Co.

*From advertisement, this issue

LITERATURE

E. M. FLYNN

Catalysts.....An experienced technical staff will assist you in developing the best & most economical catalyst. Available in tablet, powder, granule forms etc.

46 *Harshaw Chemical Co.

Diatomite.....the mineral filler, Celite that adds strength . . . soaks up dirt . . . controls gloss in paints. Available in a wide range of grades. Additional information available.

40-41 *Johns-Manville

Ethylene.....is major chemical building block available to the CPI today. To make alcohol, polyethylene, ethyl chloride, ether; for refrigeration. For sale in cylinders.

33-34a *U. S. Industrial Chem. Co.

Fabric Conditions.....Technical bulletin 12C, 8 p., describes formulations and properties for use of company's fatty nitrogen, Aliquat H226 as a textile softener.

239A General Mills, Inc.

Grease.....Rykon grease has a unique non-soap, organic thickener. Resists chemical action & has anti-rust properties. Unique properties make it multi-purpose. Facts.

38 *Standard Oil Co. (Indiana)

Hydrated Aluminas.....The low soda level makes it ideal for use as a noncontaminating catalyst base or as an ingredient material for fine aluminum chemicals. Details.

95 *Aluminum Co. of America

Maleic Anhydride.....Tablets offer fewer fines and less dusting. They have uniform chemical analysis and unsurpassed color. Ideal shape & composition for easy use.

93 *Allied Chem., Nat'l Aniline Div.

Molecular Sieves.....used to dry jet fuels. Examples are acetone & other ketones, ethanol & other alcohols, & most saturated & unsaturated hydrocarbons.

135 *Linde Co., Div. Union Carbide

Phenolic Resin.....6 p. leaflet describes Durez 16771, a high impact phenolic molding compound reinforced with Fiberglas. Charts give physical properties, effects of molding.

239B Durez Plastics Div.

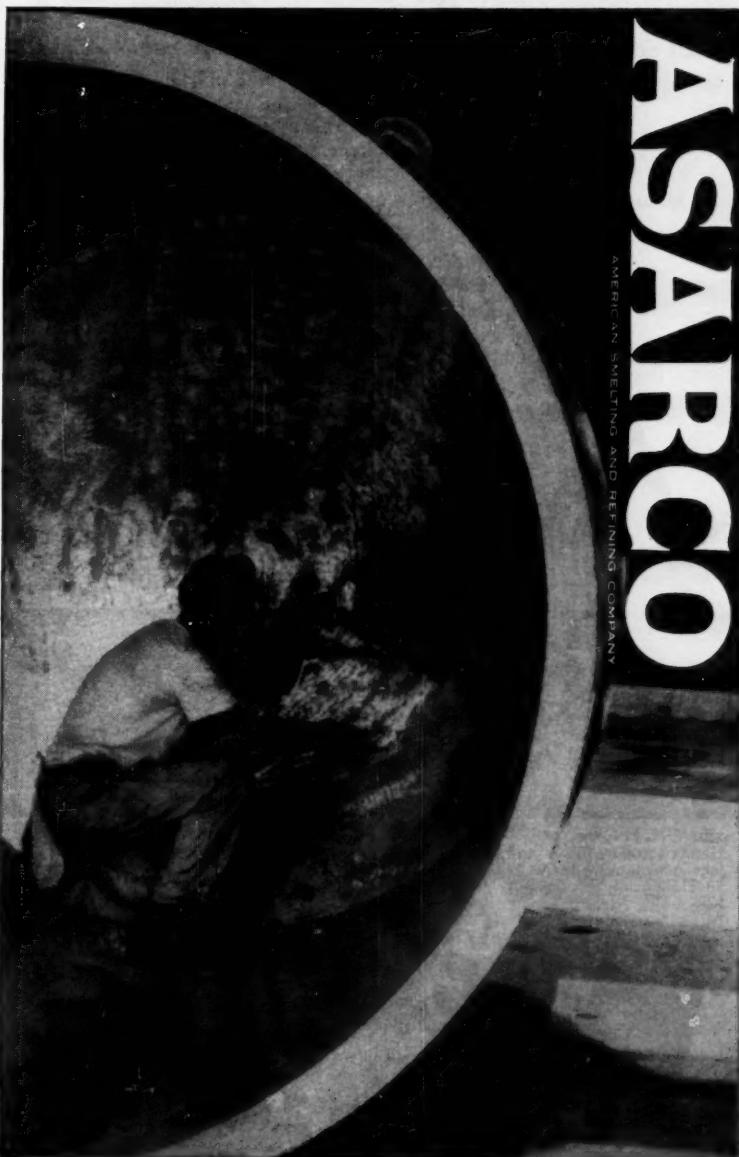
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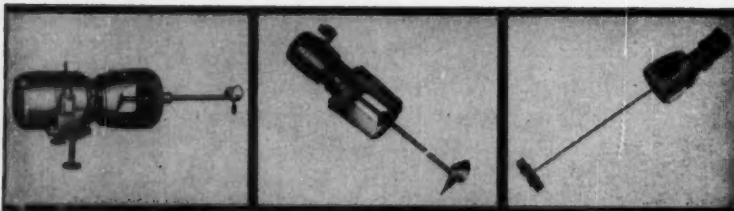
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EASTERN'S COMPLETE LINE of fluid mixers range from fixed-mounted 40 H.P. turbines and heavy-duty propeller mixers to lightweight portables. Where fixed-mounted installations are not required, Eastern Portables offer versatility, ease of handling and long-term cost savings.

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Handle the extra heavy-duty jobs in big tanks. Sizes $\frac{1}{2}$ to 30 H.P. Send for Bulletin 620.

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Designed for heavy-duty applications requiring agitators from $\frac{1}{2}$ to 10 H.P. Send for Bulletin 620.

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Range of $\frac{1}{4}$ to 40 H.P. solve many special mixing problems. Send for Bulletin 1210.



NEW PORTABLE
MIXER BULLETIN

Eastern's improved line
is included in the revised
Bulletin No. 530.

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LITERATURE . . .

Platinum Catalysts . . . High level of purity in production of chemicals, vitamins & biotics. Brochure, "The Role of the Platinum Group Metals As Catalysts." 14-15a *Engelhard Industries, Inc.

Polyethylene Reflector . . . is used in Training Reactor. It uses two types of reflectors, polyethylene & graphite with thicknesses varying from three to ten inches. 33-34d *U. S. Industrial Chem. Co.

Potassium Nitrite . . . Two grades; Crystal Technical, in 200 lb. polyethylene-lined steel drums & Crystal Reagent, in 100 lb. polyethylene-lined drums. Tech. Data. 77 *Allied Chem., Gen. Chem. Div.

Resin, Flooring . . . 2 p. bulletin describes a new polymer resin said to be superior to epoxy resins as a sealer for wood and concrete floors. Specifications. 240A Multi-Clean Products, Inc.

Silicone Rubber . . . 10 p. Bulletin CDS-170 gives product and use data on 3 new room temperature vulcanizing products for electrical potting and encapsulating. 240B General Electric Co.

Sodium Dispersions . . . Soluble sodium complexes prove valuable for Wurtz reactions & metalations. Sodium dispersions brochure available on request. 33-34b *U. S. Industrial Chem. Co.

Synthetic Gum . . . The 60 - page Methocel Book describes properties & uses of versatile synthetic gums. Exceptional capabilities as thickeners, stabilizers, film formers, etc. 74-75 *The Dow Chemical Co.

Thermoplastic Polymer . . . "The ABC's of Penton for Corrosion Resistance" plus a technical brochure designed for equipment manufacturers is available on request. 99 *Hercules Powder Co.

Urethane Foam . . . Three bulletins in a convenient folder cover Rigitthane 112 foaming resin. Includes properties of catalysts, types & names of available release agents. 240C Thiokol Chemical Corp.

Wax . . . Pentaerythritol ester of stearic acid is the subject of 2 p. product data sheet 237. Product specifications, outstanding characteristics, compatibility. 240D Hercules Powder Co.

Construction Materials

Aluminum Alloys . . . Literature is now available on the resistance of aluminum alloys to weathering & resistance of aluminum alloys to contaminated atmospheres. 6-7a *Aluminum Company of America

Cement . . . One-Cote cement insulates, protects & finishes. Effective insulation at temp. up to 1000 F. Ideal for outdoor or indoor installations. Sample offered. 64 *Eagle-Picher Company

Coating . . . Kanigen nickel-alloy coatings provide corrosion resistance & product contamination protection to process equipment of any size. Bulletin #258. 87 *General Amer. Transp. Corp.

* From advertisement, this issue

Coatings Epon resin-based coatings are sprayable, solventless. They cut application time, eliminate solvent losses & fire hazards. Information on new coatings.

Cover *Shell Chemical Corp.

Gaskets Folder AD-104 outlines the spiral wound guardian gaskets for high temperatures & pressures against steam, oils, gases, liquids, etc. For pressures to 2500 psi.

14B *The Garlock Packing Co.

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10-11 *The Colorado Fuel & Iron Corp.

Lead fights corrosion & is one of the most efficient & economical protection materials against many acids. Write for the lead handbook, Bulletin No. 162.

239 *Federated Metals Div. of Asarco

Metallic Medium for filtration, straining, distribution and dispersion. Lasts longer in centrifugals, filter presses, ion exchange towers.

Bul. 582.

BL251 *Multi-Metal Wire Cloth Co.

Teflon Products Manufacture and description of Teflon tubing, rod, extruded shapes, etc. covered in new bulletin. Information includes design and engineering services.

241A Pennsylvania Fluorocarbon

Electrical & Mechanical

Bus Design includes connectors, fittings and bus supports. All joints are high pressure, with silver-to-silver contact. Information available.

191B *I-T-E Circuit Breaker Co.

Circuit Breakers limit arcbreak current to 60,000 amperes or less. Completely automatic protection of unattended stations. Information available.

191A *I-T-E Circuit Breaker Co.

Condulets Descriptive literature and specifications on types DMC and WMC combination line starter condulets are offered for your information.

72 *Crouse-Hinds Co.

Drives, Cooling Tower A new series of bevel, spiral-bevel & worm gear cooling tower drives available in a complete range of sizes & capacities. Catalog CT-591.

112 Philadelphia Gear Corp.

Gaskets Armalon gaskets seal securely and last longer. Send for booklet, "Armalon" for details on how & where Armalon performs to best advantage.

139 *E. I. du Pont de Nemours & Co.

Gear, planetary for high speeds high horsepower. Small size, light weight; wide application; convenient arrangement. Bulletin 2400 gives other features.

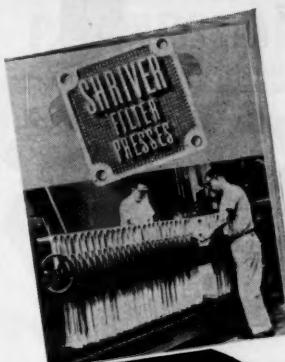
18-19 *DeLaval Steam Turbine Co.

Gears High-speed reduction gears in twelve frames are available for most economical turbine speed selection in low-speed applications. Information available.

22-23c *Westinghouse Electric Corp.

* From advertisement, this issue

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FIGURE the filter area and capacity required for your process and the size of filter press needed.

DETERMINE COST of the filter press based on its size and required materials of construction.

SELECT the filter press design and type best suited to your needs.

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ENGINEERING
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Is the fluid
Corrosive
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a SHRIVER DIAPHRAGM PUMP

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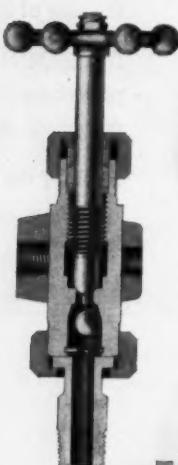
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- GAGE VALVES
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LITERATURE . . .

Generators, Inert Gas . . . with the famous industrial carburetor. Better quality control & increased safety, at lowest operational cost. Bul. I-10.

195 *C. M. Kemp Mfg. Co.

Linear Operator . . . The new, automatic, compact LimiTorque linear motorized valve operator is covered in detail in Bulletin 20-58. Operates your plug valves in 8 to 16 seconds. 32 *Philadelphia Gear Corporation

Mechanical Seals . . . Bulletin B-111 contains the complete information on quick-change rotary mechanical seals for pressure & vacuum mixing. 270c *Mixing Equipment Co., Inc.

Motors . . . Ribbed-frame enclosed motors include ratings up to 300 hp. Important facts about these motors are given in new Bulletin PB-6000-2 which is offered. 65 *Elliott Co.

Motors . . . GEA-6814 describes, in text and illustrations, design features, construction and applications of high-speed synchronous motors for industrial use. 242A General Electric

Motors . . . Explosion-proof chemical motors built with cast-iron housings to provide exceptional corrosion resistance to etching vapors & corrosive gases. Bul. 800. 138 *The Louis Allis Co.

Power Switching Centers . . . are furnished in two sizes, 3000 and 6000 amp., & are rated at up to 250 volts. Contacts may be replaced without dismounting. 191c *I-T-E Circuit Breaker Co.

Reactors . . . Glasteel 59 gives more thermal shock protection, greater abrasion resistance & longer service. Sizes & specifications are available on request. 42-43b *Pfaudler Permutit, Inc.

Starters . . . Details on high-voltage air break starters for all types of motors; only one moving part. No filing or dressing necessary. Send for Publication 6080. 131 *Allen-Bradley Co.

Turbine Drives . . . features include forced-feed lubrication to turbine & gear bearings, and automatic shutdown & alarm in case of low oil pressure. Bul. S-140. 58 *The Terry Stearn Turbine Co.

Turbines, Multi-Stage . . . Five frame sizes available with speeds to 16,000 rpm & horsepower to 50,000 for paper machine drives, power plant generation up to 5000 kw. 22-23b *Westinghouse Electric Corp.

Turbines, Single-Stage . . . Seven frame sizes available with horsepower from 5 to 4000, speed from 1000 to 12,500 rpm. For pumps, fans, compressors, blowers, etc. 22-23a *Westinghouse Electric Corp.

Handling & Packaging

Conveyor, Pneumatic . . . Bul. I-28 tells how to select, operate & maintain systems for transporting dry, bulk materials. Positive, negative & combination systems described. 35b *Sprout-Waldron & Co., Inc.

* From advertisement, this issue

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FOR FASTEST
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1/4"	3/8"	1/2"	3/4"
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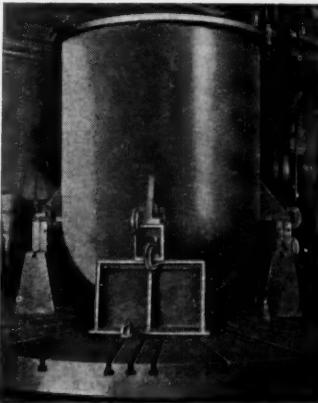
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Tensile Strength—32,800 psi

Machining operation shown is being done in our Machine Shop. Cast of Ductile Iron.

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In order to provide liquid sulphur conveniently to industrial users of the Tampa area, DeBardeleben Marine Corporation will transport, in a specially-designed ship, liquid sulphur from the Texas Gulf Sulphur Company's loading terminal at Beaumont, Texas, by sea to Tampa, Florida. DeBardeleben's initial storage facilities at Tampa will provide for 12,000 tons of liquid sulphur, with existing storage facilities caring for 50,000 tons of solid sulphur. This will be available for distribution to users, in any quantity, via tank cars and trucks. The sea-going sulphur vessel will also carry ammonium sulphate, potash, salt cake, ore, phosphate rock, superphosphate, triple superphosphate, and other dry, bulk commodities between Gulf ports. This will be the first liquid sulphur terminal in the Florida area.

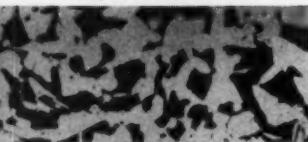
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LITERATURE . . .

Cooler & Dryer, Pellet....The industrial Rotairecool for drying & pneumatic conveying of pellets. Has major redesign features. Complete details in Bulletin 202.
35a *Sprout-Waldron & Co., Inc.

Cylinders....for high & low pressure shipment of compressed gas. Uniform weight & capacity simplify filling, handling & record-keeping. Wide range of types. Details.
13 *Pressed Steel Tank Co.

Industrial Trucks....A new industrial trucks selector guide will be of assistance to materials handling men in setting up new or revised systems. 20 pages.
244A Automatic Transportation

Lift Truck....New FTP-20, 2,000 lb. truck with pneumatic tires will climb 34% grade with full load. Has 35 hp, 97 ft-lb of torque. Send for bulletin BU-493.
220 *Allis-Chalmers

Materials Handling Truck....The Liftomatic is designed & constructed to eliminate use of hooks, & additional man-power in moving containers & chimes. Bulletin.
244B Marvel Industries, Inc.

Packaging....Heavy-duty polyethylene bag in 5 gal. drum being used to pack reagents such as sodium & potassium hydroxide, phosphoric acid, formaldehyde, etc. No. 1468. 33-341 *U. S. Industrial Chem. Co.

Polyethylene Tank....for corrosive solutions contains inner polyethylene basket to hold parts to be dipped. Tank is 12" x 26" x 12". No. 1461.
33-34f *U. S. Industrial Chem. Co.

Power Truck Attachment....fits any truck & handles any drum. Illustrated bulletin offers complete specifications & other details of this Lifomatic attachment.
244C Marvel Industries, Inc.

Tanks....of carbon & stainless steel for chemical storage. Also pressure vessels & processing equip. of aluminum & special alloys. Booklet "Tank Talks" is offered.
BL217 *R. D. Cole Mfg. Co.

Heating & Cooling

Combustion Systems....High-velocity air heating combustion systems are individually job engineered using standard components. Complete information on request.
214 *Eclipse Fuel Engineering Co.

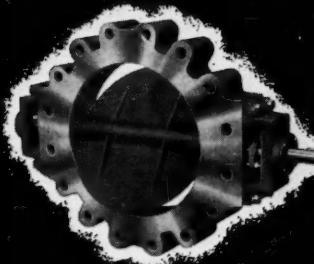
Electric Heat....for faster heating of water, oils, Dowtherm, Prestone; faster melting of grease, asphalt, solder, babbitt; faster superheating of steam, compressed air.
208 *Edwin L. Wiegand Co.

Furnaces....Bulletin 653A describes the complete line of electric and fuel-fired heat-treating furnaces and protective atmosphere generators produced by manufacturer.
244D Hevi-Duty Electric Co.

Heater, Air....have extreme compactness, high efficiency & versatility of operation. Performs equally well on gas, oil or combination firing. Bulletin 112.
250 *Thermal Research & Engr. Corp.

* From advertisement, this issue

HOW MANY WAYS CAN A BUTTERFLY VALVE SERVE YOU?



The application of Fisher-Continental Butterfly Valves is virtually limitless in the gas, vapor, liquid or semi-solid flow control industries. These compact, low cost controls fit the specifications of a vast majority of applications.

FISHER-CONTINENTAL GIVES YOU FULL FREEDOM OF CHOICE

For gas, vapor, liquid or semi-solid control problems specify Fisher-Continental Butterfly Valves—any size . . . any metal or alloy . . . any temperature . . . any fluid . . . any pressure . . . any condition . . . any operator, manual or power.



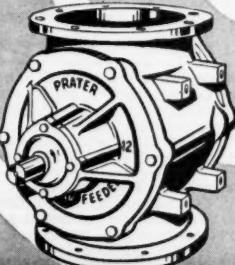
For complete details about Fisher-Continental
Butterfly Valves send for free literature.



FISHER GOVERNOR COMPANY
Marshalltown, Iowa/Woodstock, Ontario/London, England
Direct Inquiries To:
CONTINENTAL EQUIPMENT CO. DIVISION, CORAOPOLIS, PENNSYLVANIA

2000 PROCESSING PROBLEMS SOLVED BY PRATER AIRLOCKS

SEND YOUR AIRLOCK FEEDER PROBLEM TO PRATER



Write for Your Copy
of "How to Select a
Rotary Airlock Feeder"
Bulletin P58

PRATER PULVERIZER COMPANY
1517 SOUTH 55TH COURT • CHICAGO 50, ILLINOIS

ADAMS

FACT FILE #3

INSTRUMENT AIR

Clean Dry Air Supply Will Reduce Production Down-Time . . . Instrument Maintenance . . .

Wet, dirty compressed air has no place in the process industries. In instrument air supply lines it can cause havoc. Whether it be motor air in a control circuit or supply air to the control panel, absolutely clean dry air is vital. Moisture elimination is the major consideration in providing suitable air for instrument and control systems.

Since most plant compressors in use today are oil lubricated, a finite amount of oil is present with the water vapor in the discharge. This carry-over condenses as an oil-water emulsion which often causes serious fouling of instrument components. To eliminate this oil-moisture condensate in the air lines, it is necessary to remove it before it reaches the distribution system. This is done by cooling the air before the receiver. It is advisable to cool well below the ambient conditions to provide the lowest possible humidity at the instrument panel or control units.

Two Stage System Design for Economy
The ideal method to achieve high quality air is a two-step operation.

1—An Adams Aftercooler . . . providing 2° F. cooling . . . and Cyclone Separator installed between the compressor and receiver to remove the bulk of moisture carry-over.

2 — A chemical dryer installed down stream to provide the polishing action necessary for the desired minimum humidity.

Thus, the bulk of water . . . 90% . . . is removed by the Aftercooler-Separator using plant water for cooling. A minimum moisture load is then left to be removed by more expensive methods. Under normal circumstances, all of the oil present in the compressor discharge will be removed in the Aftercooler-Separator. Fouling of the chemical unit is then virtually eliminated.

Poro-Stone Air Filter at Panel Provides Dirt-Free Control Air . . .

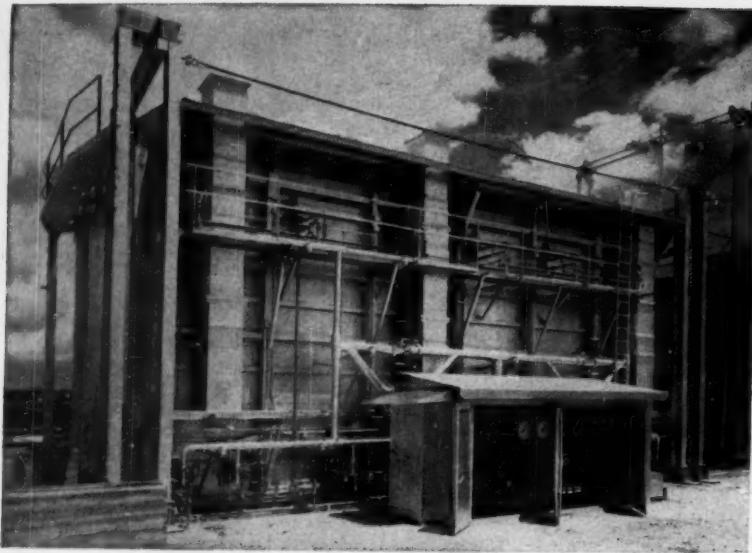
In spite of the efficiency of the Adams Aftercooler and Separator, there still will be some dust and dirt present in the instrument air system. That's why it is advisable to install an Adams Poro-Stone Air Filter in the line just before the control panel.

Separation by the Adams unit is in two stages — centrifugal and diffusion. Centrifugal force throws the foreign matter to the walls of the filter body where it is trapped in slots and drained. Remaining particulate matter is removed as the air passes through the pores of the Poro-Stone element.

This final protection for your instruments will minimize control system failures and process down-time. Instrument maintenance will be sharply reduced.

Literature Will Help Air System Design

For further information on how the complete line of Adams air equipment can help you provide foolproof instrument air supply, write today for your copy of Bulletin No. 712 on Aftercoolers and Separators and Bulletin No. 117 on Poro-Stone Air Filters to the R. P. Adams Company, Inc., 207 East Park Drive, Buffalo 17, New York.



AVONDALE

a new name in the chemical field

NEW FACILITIES . . . at Avondale Marine Ways now make it possible to offer a wide range of products and services directly to the chemical and petrochemical industries. In addition to large plate rolls for heavy steel fabrication, there is the specially designed, automatically controlled furnace with temperatures up to 2100°F. shown above.

Through the use of these facilities, Avondale can produce ASME Code Stamped pressure vessels to 4 in. thickness and up to 18 ft. in diameter and 300 ft. in length.

Write for our complete brochure,
Heavy Steel Fabrication



Industrial Division
AVONDALE
MARINE WAYS, INC.

VERSATILE BUILDER ON THE MISSISSIPPI

416 ERATO ST. • JACKSON 2-3836 • NEW ORLEANS 13, U.S.A.

LITERATURE . . .

Heat Exchanger Tubes . . . U-Bend tube is available in uniform gauge, as well as with thickened center. Sizes range from $\frac{1}{2}$ " o.d. to 1" o.d. Details: 183 *Chase Brass & Copper Co.

Heat Exchangers . . . Literature on the applications of aluminum alloy heat exchangers in the process industries is now available on request. No. 20437.

6-7b *Aluminum Co. of America

Liquid Heater . . . operates at atmospheric pressure. Generates & delivers heat up to 650 F. Bulletins containing complete information on this new liquid heating system. 114 *Allis Chalmers, Hydraulic System

Thermo Panel S. S. Kettle . . . There is no jacket & no pipe coils. Heat transfer is most efficient; construction most economical. Complete data and prices available. TL255 *Dean Products, Inc.

Instruments & Controls

Control . . . The Airtrol automatic process control responds to a 3 to 15 p.s.i. pneumatic signal & is adaptable to all standard process instrumentation. Data Sheets. 123 *Reeves Pulley Co.

Control, Checkweighing . . . Continuous 100% in-line checkweighing of items from 50 to 200 lbs. at speeds to 40 per minute. Handles sacks, cartons, etc. See Bulletin 2968. 267b *Toledo Scale Corp.

Controller, 3-in-1 . . . combines controller, positioner & valve; gives precise control of temperature or pressure. Half the cost of 2 & 3-unit systems. Bulletin GC-755. 219 *Robertshaw-Fulton Controls Co.

Controls . . . Information on controls service including transmitters. The Libratrol-500 digital computer, data-processing systems & valve actuators is available. 105 *G P E Controls, Inc.

Controls . . . Remocon systems provide automatic remote control of single or multiple scale batching systems. Complete information in Bulletin 2964. 267a *Toledo Scale Corp.

Controls, Liquid Level . . . have no moving parts in liquid; easy to install; unaffected by acids or caustics; unaffected by pressure or temperature. Send for catalog. TL217 *Charles F. Warrick Co.

Dial Thermometers . . . A complete line is available with wide temperature ranges, dial sizes, patterns and finishes. A new catalog covers all details. TL249c *Marsh Instrument Co.

Gages, Liquid Level . . . Direct reading type designed with exclusive features for range of pressure, temperatures, corrosive conditions or other specific requirements. 242a *Penberthy Mfg. Co.

Indicating Transmitter . . . Bul. 21-10 describes the Type 630 Indicating Transmitter in detail as well as the many other instruments in Electronic Consotrol System. 107 *The Foxboro Company

* From advertisement, this issue

Instrument.....to measure internal corrosion & record it hourly is now available. A dual-element probe provides the measure. Complete information in No. 1462.
33-34g *U. S. Industrial Chem. Co.

Instruments.....Complete technical information on integrated systems of measurement, recording or control, pneumatic or electronic for your plant.
16-17 *The Bristol Company

Instruments, Pneumatic.....Tel-O-Set miniature instruments accurately record, indicate, & control process variables. For complete information, Catalog C 100-1a.
20-21 *Minneapolis-Honeywell

Level Control.....Gagetron provides a permanent, efficient control & measurement under severe operating conditions in process vessels & piping. Write for bulletin.
222b *Instruments, Inc.

Level Indicator.....Electr-o-level for liquids, solids, viscous fluids, acids & granular materials. More economical unit for use where extreme accuracy is not required.
222c *Instruments, Inc.

Level Indicator, Liquid & Solid.....Electr-o-probe detects liquid & solid levels, liquid-liquid interface or foam-liquid interface. Explosion proof design. Bulletin.
222d *Instruments, Inc.

Level Indicator.....Radionic determines liquid or solid level within a closed vessel using nuclear radiation. Unaffected by extreme pressures & temperatures. Bulletin.
222a *Instruments, Inc.

Magnetic Flowmeter.....for measuring wet-process phosphoric acid accurately. Rate of flow is measured to better than 1% accuracy. Catalog 10D1416.
199 *Fischer & Porter Co.

Meters, Liquid.....Designs to measure most anything that flows...including all stainless steel meters for corrosive liquids. Full details on meters & accessories.
47 *Rockwell Mfg. Co.

Needle Throttling Valves.....gives micrometer regulation at high pressures. Pressure up to 10,000 psi and any temperature up to 500 F. Catalog available.
TL249b *Marsh Instrument Co.

Pressure Gauges.....combine features of pressure vacuum and compound gauges. There is a gauge for every conceivable application. New catalog for details.
TL249a *Marsh Instrument Co.

Pressure Indicator.....Press-I-Cell, a servo-operated precision pressure indicator is of rugged, compact design suitable for production use or as a lab standard. Bulletin.
247A *Fischer & Porter Co.

Radioactivity Instruments.....New 76-page catalog describes more than 125 products available for detecting, counting and recording radioactivity. 35 new products.
247B Nuclear-Chicago Corp.

Safety Gage Case.....A new completely safe safety gage case for all high-pressure applications is described in catalog of pressure gages. Types, sizes, materials.
247C Kunkle Valve Co.

* From advertisement, this issue

For SPEED, SIZE, SAVINGS and SAFETY

FLETCHER SUPER CENTRIFUGALS

SOLVE YOUR PROBLEMS

Call on Fletcher to solve your toughest problems in centrifugal engineering.

For example, this super-suspended centrifugal—the Fletcher Super-S-Omatic broke through the speed barrier. Until it was developed, no centrifugal of this size existed that achieved 1600 RPM = 1750 G's.

This Fletcher centrifugal, with a gravity of 1750 G's, is coupled with a production rate of 16 cubic feet per batch. This unit is capable of 6 production cycles per hour.

The Fletcher Super-S-Omatic features infinite variable speed by fluid mechanical drive. It's completely automatic—at the touch of a button it automatically starts, feeds, skims, brakes, unloads and then recycles.



FLETCHER ELECTRO-NUMATIC BRAIN

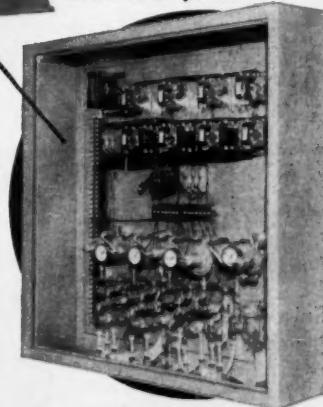
Eliminates all possibility of human error. Assures perfect performance. Completely safety interlocked. Cuts labor costs 100%.

Regardless of how intricate the schedule of centrifugation, the Fletcher Electro-Numatic Brain thinks it through all the way.

FLETCHER PILOT PLANT CENTRIFUGAL



Rugged, compact machine combines functions of extractor, separator and clarifier. Results from this test unit can be accurately scaled up to production unit.



WHEN in Philadelphia Visit The Fletcher Operating Centrifugal Exhibition.

ASK ABOUT THE FLETCHER RENTAL PLAN

The New Fletcher Works, Inc.

CENTRIFUGAL DIVISION

203 Glenwood Ave • Philadelphia 40, Pa.

Send me additional information on the Fletcher Centrifugals.

NAME & TITLE _____

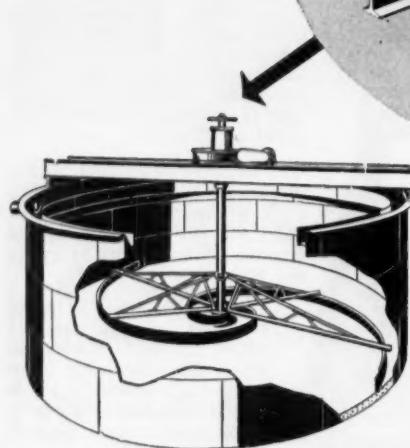
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COMPANY _____

CITY & STATE _____

Hardinge

"AUTO-RAISE" THICKENERS



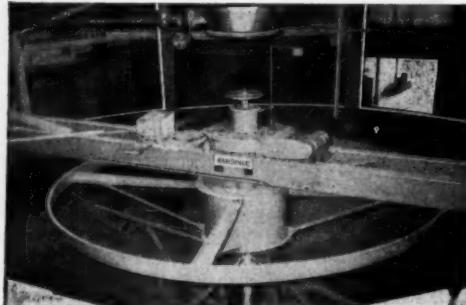
The higher the solids content in the thickener underflow, the lower the cost of filtering for subsequent processing or disposal.

The spiral rakes of the Hardinge Thickener compress the solids to maintain high density of underflow.

The "Auto-Raise" drive mechanism prevents overloading as the underflow is thickened.

Submerged parts may be supplied with rubber or lead covering or fabricated from wood or any metal available for structural parts.

Complete specifications upon request. Bulletin 31-D-11.



A 35' diameter "Auto-Raise" Thickener with "froth ring".

HARDINGE

COMPANY, INCORPORATED

YORK, PENNSYLVANIA • 240 ARCH ST. • Main Office and Works
New York • Toronto • Chicago • Hibbing • Houston • Salt Lake City • San Francisco • Birmingham • Jacksonville Beach

LITERATURE . . .

Pipe, Fittings, Valves

Butt Weld Fittings Sanitary fittings & valves are outlined in Catalog W-159. Contains illustrations, specifications and complete data for all requirements.
248A Ladish Co., Tri-Clover Div.

Connectors Hose assemblies of Teflon, designed to meet tough problems—temperature extremes, corrosion, high pressure, etc. Send for catalog No. TC-101.
145 *The American Brass Co.

Connectors, Flexible MNH flexible connectors dampen vibration, permit offset movement, absorb expansion, etc. Fact-filled Allflex Engineering Data Sheet offered.
TL243 *Allied Metal Hose Co.

Ejectors Hydraulic, air & steam operated ejectors simplify handling of fluids, vapors, gases & hot materials; in a variety of standard & special designs.
242c *Penberthy Mfg. Co.

Fittings, Ductile Iron with high strength, improved thermal shock, excellent corrosion resistance, & widely used in the petroleum industry. Information available.
42-43a *Pfaudler Permutt, Inc.

Fittings, Welding Catalog 54 gives complete information on welding fittings. Elbows & tees are made of stronger metal & fittings are reinforced at points of stress.
97 *Midwest Piping Co., Inc.

Pipe Bondstrand fiber glass reinforced epoxy pipe holds up under the corrosive action of many salt, acid and alkaline solutions. Easy to install.
61 *Amercoat Corporation.

Pipe & Fittings, PVC Bulletin PF1200 contains data relative to physical properties, chemical resistance, pipe, threaded fittings & socket fittings.
248B *Luzerne Rubber Co.

Pumps, Slurry permit proportion of slurries to remain constant in mix tank—while pumping rate is variable from maximum. Free catalog gives complete details.
TL225 *Manzel

Spray Nozzles Complete & accurate performance data for each of the hundreds of spray nozzles in the line. Includes dimensions, flow rate, pressure, etc.
232 *Spray Engineering Co.

Spray Nozzles Complete information on spray nozzles contained in Catalog 24. Offered in a wide range of types & capacities for every application.
216 *Spraying Systems Co.

Tubes for heat exchanger. Includes tube tolerances and mechanical properties, wide range of steels & complete range of tube sizes. Write for Bulletin TB-329.
153 *Babcock & Wilcox Co.

Tubes, Condenser U-bend condenser tubes are prefabricated to your specifications. Ready for insertion into your heat exchanger.
133a *Calumet & Hecla, Wolverine Tube Div.

* From advertisement, this issue

*First choice of the rocket
and missile industry...*

Three superlative Marsh products
are widely used and approved by
the aircraft and missile industry:

MARSH Pressure Gauges...

because they combine the most advanced
features ever found in pressure, vacuum and
compound gauges. There is a Marsh Gauge
for every conceivable application.



All Marsh products available with AND threads

MARSH

*New catalog
comes all
details*

MARSHINSTRUMENT CO., Sales Affiliate of Jas. P. Marsh Corp., Dept. 24, Skokie, Ill.
Marsh Instrument & Valve Co., (Canada) Ltd., 8407 103rd St., Edmonton, Alberta,
Canada. Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas

FILTER TIPS

by E.D.FILPAPER

WE'RE HAVING TROUBLE WITH
FILTER PAPER DELIVERIES

WELL, DELIVERY IS NO PROBLEM
FOR EATON-DIKEMAN



BUT YOU SEE, THIS IS A
HORIZONTAL PLATE FILTER

E-D STANDARD GRADES AND
SIZES OF CIRCLES ARE
IMMEDIATELY AVAILABLE
FOR THIS FILTER



BUT WHAT ABOUT COST

OUR PRICES ARE COMPETITIVE
...AND FREQUENTLY, LESS
EXPENSIVE PAPERS CAN BE USED



THAT'S WONDERFUL.
HOW DO YOU
PEOPLE DO IT

AFTER ALL, WE'VE
SPECIALIZED IN FILTER
PAPERS FOR 70 YEARS

For more information, and FREE samples of E-D Filter Papers, write to

THE EATON-DIKEMAN CO.

Filtertown

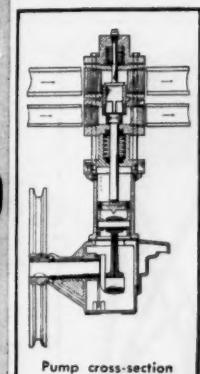
Mt. Holly Springs, Pa.

"First with filter paper exclusively"



New

**LOW COST
Metering and Feed
PUMP**

Pump cross-section

New pipe line metering feed pump is the ideal answer to metering, feeding, injection and other processes requiring positive displacement pumping... at a low cost. It is well-suited to pumping slurries and viscous materials. Multiple inlet and discharge ports are particularly well-adapted to pumping from one circulating stream to another. The packing gland is on the low pressure side; high pressure packing is eliminated. It is well-suited to continuous processes requiring incremental slug feeding. It is available in capacities to 1 GPM and in a variety of construction materials.

Write today for complete information.

SIGMAMOTOR, INC. 17 N. MAIN ST. • MIDDLEPORT, N.Y.

PACKAGED AIR HEATERS by THERMAL

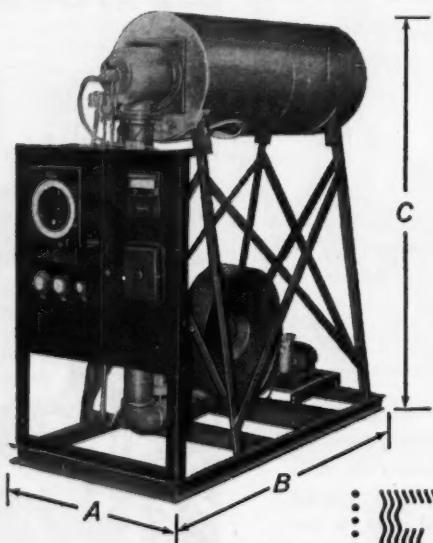
Extreme compactness, high efficiency and versatility of operation are the chief characteristics of the THERMAL Type CA direct fired air heater. Designed around the high velocity THERMAL burner, it normally requires no refractory, since combustion is limited almost entirely to the burner itself. Adding to its versatility, the CA air heater performs equally well on gas, oil or combination firing and can be adapted to all pressure levels.

Type CA air heaters are most frequently sold as "packaged" units complete with all necessary safety and control apparatus. These units will provide outputs ranging from 200,000 BTU/hr to better than 30,000,000 BTU/hr and at temperatures from 300F to 1500F or higher.

TYPICAL SIZES . . .

Listed below are the overall dimensions of a few of the dozens of output, temperature, and flow combinations possible in these heaters. Figures are for atmospheric pressure units. Higher pressure heaters would be smaller.

BTU/hr	AIR FLOW scfm	TEMP. IN °F	TEMP. OUT °F	A ft.	B ft.	C ft.
800,000	1,000	60	750 F	2½	4½	4
2,500,000	5,000	60	500 F	4	7	6
4,000,000	16,000	700	900 F	7	11	8
10,000,000	8,500	60	1,000 F	5½	10	8
15,000,000	10,000	60	1,200 F	6	12	8



Write for Bulletin #112

THERMAL

Thermal Research & Engineering Corp.

CONSHOHOCKEN • PENNSYLVANIA

REPRESENTATIVES IN PRINCIPAL CITIES



Other Thermal Products & Services:

- Gas, Oil & Combination Burners
- Heat Exchangers
- Gas Generators
- Submerged Combustion
- Combustion & Heat Transfer Equipment

LITERATURE . . .

Tubing . . . Complete information on Trufin type L/C Bimetal and Trufin type S/T Duplex tubing is now available.

133b

*Calumet & Hecla, Wolverine Tube Div.

Tubing, Stainless Steel . . . Welded stainless steel tubing resists corrosion, high temperature and contamination. Complete details on this tubing in Bul. 8591.

53 *Formed Steel Tube Institute, Inc.

Unions . . . offer the widest application in high pressure-high temperature piping. Booklet "What makes a good union—" is now available.

244

*Clayton Mark & Co.

Valves . . . Instant, split second action with full flow, available in Sentry Latch type & Sentry Piston type valves. Detailed information in Bulletin 500.

163

*Coppus Engineering Corp.

Valves . . . Full nozzle safety-relief valves with standard design features; simplicity in design, safety in operation. Send for Catalog FE-118.

210

*Farris Engineering Corp.

Valves . . . Continental Butterfly type can be made to your specifications, of any metal, to withstand any temperature or pressure desired. Sizes range from 2" to 36".

TL245

*Fisher Governor Co.

Valves . . . New Gate & Globe are available from stock in $\frac{1}{4}$ " thru 2" sizes & in both socket weld & screw ends. Feature hard faced seats & hardened discs & wedges.

156

*Henry Vogt Machine Co.

Valves . . . Catalog No. 11-A-1 outlines the different series of valves & valve accessories. Illustrations, charts & flow curves are included. Send for your copy.

250A

*Hoke Incorporated

Valves, Air Actuated . . . meet a wide range of dairy, food & beverage industries processing operations. Basic dimensions & flow diagrams in Bulletin A-658.

250B

Ladish Co., Tri-Clover Div.

Valves, Ball . . . feature two sealing surfaces for less wear & less care; valves in pipe sizes $\frac{1}{4}$ " to 8" in bronze, aluminum, stainless steel, carbon steel & PVC Quarter Turn.

215 *Jamesbury Corp.

Valves, Ball . . . The new "316" gives positive sealing over a wide range of pressures. Complete line of Ball Valves are described in a new catalog.

51

*Rockwood Sprinkler Co.

Valves, Diaphragm . . . of ductile iron with glass lined bodies. Feature a wide selection of body linings; glass, rubber, neoprene. Bonnet materials; ductile iron, grey iron.

45

*Grinnell Company, Inc.

Valves, Diaphragm . . . lined with Penton plastic & equipped with one-piece Teflon-faced diaphragms. Bulletin 115 outlines packless, drip-tight diaphragm valves.

98

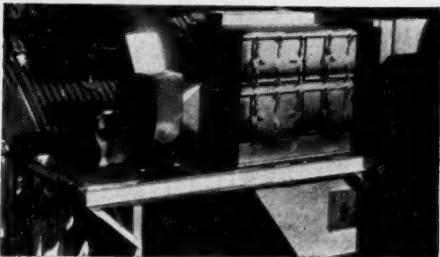
*Hills-McCanna Company

Valves, Gage . . . feature exclusive "floating shank" which save on installation, eliminates strains common to forced installations. Special valves & accessories.

242b

*Penberthy Mfg. Co.

* From advertisement, this issue



Barely visible discharge from exhauster in this unretouched photo shows how Dustex Miniature Cyclone Collector ended a problem for Perlite Products Co.—while recovering 70 lbs./hr. with no maintenance.

**"95% PREDICTED
EFFICIENCY
PROVED . . .**

and Collector is
maintenance-free!"



Frank W. Schaffer, President of Perlite* Products Co., Primos, Pa., writes this about his Dustex Miniature Cyclone Collector purchased on a basis of the Dustex Single Tube Determination test:

"Your predicted efficiencies of 95% are proven ... collecting 70 lbs./hr. of 85% below-325-mesh material at 450°F... complaints on discharge are ended, and the collector is maintenance-free."

*Perlite . . . extremely lightweight material for insulation and filtration, with a bulk density as low as 3.5 lbs./cu. ft.

Write Today for Dustex Bulletin "A Simplified Test Method" describing actual collection test at your plant at no obligation.

25 ANDERSON ROAD • BUFFALO 25, N.Y.



**NEVA-CLOG
METALLIC
MEDIUM**
for
**FILTRATION
STRAINING
DISTRIBUTION
DISPERSION**



**More Efficient
More Economical
Lasts Longer in**

- Pressure Leaf Filters
- Filter Presses
- Ion Exchange Towers
- Support for Activated Granular Carbon in Processing Columns
- Control of Dust and Fumes
- Centrifugals

Write for Bulletin 582

Strong—rigid—requires little support or reinforcement. Can be formed into panels, discs, plates, cylinders, cones. Not injured by scraping, flushing or blowback. Does not clog or blind. Made in stainless steel, Monel, aluminum, Carpenter 20 steel.

MULTI-METAL WIRE CLOTH CO., INC.
1353 GARRISON AVENUE

NEW YORK 59, N.Y.

Size Requirements Getting Tougher?

**Sturtevant Air Separators
Increase 40 to 400 Mesh
Output as Much as 300%**



Closed-circuit air separation is of proved advantage in reduction processes. Result is a better, more uniform product. Grinding mills perform at top efficiency, output frequently increases as much as 300%, power costs drop as much as 50%.

Precise separation of all dry powdered materials. Sturtevants currently classify sulfur, soybeans, phosphate, chocolate, feldspar, sand and aggregates, pigments, limestone fillers, flour, abrasives, plastics, gypsum, ceramics, cement and other products.

Improve screening — Sturtevant Air Separators prevent blinding by removing undesirable tailings or fines from screen feed loads.

Works Like Winnowing Done in a Whirlwind

Sturtevant Air Separators do a mechanical job of winnowing. Precise control of whirlwind air currents and centrifugal force results in the desired size being lifted into fines cone, oversize falling into tailings cone.

A 16 ft. Sturtevant, for example, has taken a feed rate of 800 tph, containing only a small percentage of desired fines, and delivered 30 tph 90% 200 mesh, recirculating the oversize through the grinding circuit.

Send for Bulletin No. 087.

STURTEVANT

MILL COMPANY

100 Clayton St., Boston, Mass.

Crushers • Grinders • Micron-Grinders • Separators
Blenders • Granulators • Conveyors • Elevators



**STEEL PLATE
STAINLESS STEEL
STAINLESS CLAD
PLATES
T-1 STEEL AND
OTHER STEEL
ALLOYS
NICKEL-CLAD
ALUMINUM
ETC.**

HAMMOND TANKS



PLATE FABRICATION

**FIELD ERECTED
TANKS
AND VESSELS
FOR
LIQUIDS, GASSES
VAPORS
AND
STORAGE OF
DRY MATERIALS**

FIRE PROTECTION AND WATER SUPPLY



ELEVATED TANKS

HAMMOND IRON WORKS

WARREN, BRISTOL
AND PITTSBURGH, PA.
PROVO, UTAH • CASPER, WYO.
BIRMINGHAM, ALA.

Sales
offices
throughout
the U.S.A.

LITERATURE . . .

Valves, Plug . . . A complete line of lubricated plug valves with sizes from $\frac{1}{4}$ " to 36" & pressures to 15,000 lb. Complete details are available.
36-37 *Rockwell Mfg. Co.

Valves, Solenoid . . . Complete information on the entire line of corrosion-resistant solenoid valves and a time-saving rating chart are included in the Catalog.
83 *Automatic Switch Co.

Process Equipment

Agitators & Mixers . . . for slow speed, thorough stirring, high speed mixing, scrubbing, solvent extraction, solids suspension or aeration of slurries. Bul A2-B4.
226 *Denver Equipment Co.

Autoclaves . . . Available with lower first cost, minimum downtime & less maintenance. For complete details on autoclaves and other equipment, write for brochure.
266 *Bethlehem Foundry & Mach. Co.

Centrifugals . . . for speed, size, savings and safety; completely automatic. Made to solve toughest problems. Complete detailed information available.
247 *The Fletcher Works, Inc.

Centrifugals . . . Booklet No. 2648 illustrates & describes automatic dischargers, liquid vapor seal load measuring device, centrifugal baskets, basket linings, etc.
234 *The Western States Machine Co.

Dryers . . . In rotary vacuum dryers the blade clearance is adjustable down to $\frac{1}{8}$ inch. Full information on cone vacuum dryers, drum dryers & flakes is available.
1252 *F. J. Stokes Corp.

Dryers, Spray . . . Details on spray dryers for the food, chemical & process industries is contained in 8-page Bul. 442. Included are Pilot Plant Spray Dryers, etc.
113 *Proctor & Schwartz, Inc.

Dust Collectors . . . 95% predicted efficiency proved—collecting 70 lbs./hr. of 85% below-325-mesh material at 450° F; also maintenance-free. Send for bulletin TL251.
*Dustex Corp.

Dust Control . . . Ducones cyclones are designed & constructed for high recovery efficiency & low gas resistance. Offer 6 unique features. Bulletin C-958.
R256 *The Ducon Co.

Equipment . . . Glasteel 59 is now standard on all equipment for reactors, fractionation, absorption, stripping, extraction, solvent recovery, etc.
42-43c *Pfaudler Permutit, Inc.

Equipment, Water Purity . . . Used for ultra-high purity water in inside surfaces of TV picture tubes. Water purity even higher than when distilled. Send for details.
42-43d *Pfaudler Permutit, Inc.

Feeders, Airlock . . . available in standard duty, heavy duty & blow-thru types. Bulletin P-58 "How to Select a Rotary Airlock Feeder is offered.
BL245 *Prater Pulverizer Co.

*From advertisement, this issue

how to give yourself the air



Some raw materials are dirt-cheap—or even air-cheap. It's a steal when you can pump in a raft of outside air and ship nitric oxide or nitric acid out the back door. Maybe you want something less lethal from your oxidation-reduction process but whatever it is, activated charcoal when used as a catalyst does the job over and over again—and at low cost, too.

how to find a silver lining



It's clouds of money back in the till when solvent vapors go back in the process. Solvent vapors can play hob with the process—and the people. One activated charcoal solvent recovery system took the contaminant out of the air, the complaint out of the employee, and put 2000 gallons of solvent back into the process daily. Are you prepared for recovery?

activated charcoal



Activated charcoal (or carbon), a hard, granular, black material, acts as a molecular sponge, purifies air, gases, liquids—recovers solvents—removes odors and impurities—does hundreds of jobs. Write for Bulletin J-103. Barnebey-Cheney, Columbus 19, Ohio.

Barnebey Cheney



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FLUIDIZATION

Just Out. Presents in progressive fashion all the major developments of a fundamental character pertaining to fluidization, covering descriptions of phenomena, experimental data, and working formulas. Deals with the fluidized state, dilute phase and moving solids, heat transfer, mass transfer, and solids and fluid mixing. Provides the tools for applying fluidization concepts to problems of greatly diversified character. By Max Leva, Consulting Chemical Engr. 336 pp., 184 illus., \$11.50

SUCCESSFUL PROCESS PLANT PRACTICES

A thoroughly practical collection of 340 "how-to" methods and techniques for use in today's process plants. Each has proved itself in actual practice by saving time and money in such activities as managing, scheduling, operating, maintaining, and repairing. Includes drawings, photographs, and working data. By Robert L. Davidson, Senior Editor—Processing, Petroleum Week. 292 pp., 276 illus., \$10.00.

NUCLEONICS FUNDAMENTALS

Just Out. Offers a broad view of the field of nuclear physics and engineering—the accomplishments, applications, problems, and limitations associated with the use of radioactive substances in science and industry, nuclear reactors, and other nuclear devices. Covers basic atomic and nuclear physics, radioactivity, particle accelerators, instrumentation, research and power reactors, nuclear explosives, etc. By David B. Hoisington, Prof., U. S. Naval Post-graduate School. 400 pp., 159 illus., \$9.50

CREEP OF ENGINEERING MATERIALS

Just Out. Combines the fundamentals of material behavior with important applications to design problems, and supplies a clear perspective on the advantages and limitations of different materials which undergo creep. From showing the basic methods of measuring creep to pinpointing specific, elevated-temperature problems encountered in industry, the practical facts and information you need to know on this subject are provided. By Iain Finnie and William R. Heller, both of Shell Development Co. 327 pp., 126 illus. and tables, \$11.50

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CE-4-20

LITERATURE . . .

Filter Papers....free from linen & minerals. They are made under controlled conditions. Types for every need. Sample filter papers are available.
R249 *The Eaton-Dikeman Co.

Filter Press....available in a design & capacity to handle any filterable mixture & any filter material. Catalog contains erection, operating, & construction data.
231 *D. R. Sperry & Co.

Filters....Brochure contains descriptions, operation & specifications of drum filter, continuous precoat filters, Pilot Plant filters & horizontal vacuum filters. Bul. KSI-3.
253A *Komline-Sanderson Eng. Corp.

Filtration Equipment....New catalog available to help you figure the filter area & capacity required for your process & the size of filter press needed.
241a *T. Shriver & Co., Inc.

Gas Scrubbers....A new brochure giving complete data on Chemico venturi gas scrubbers is available. Their simple construction permits wide application.
12 *Chemical Construction Corp.

Laboratory Vacu-Film Processor....Areas of application, from isolation of essences & removal of odors & color bodies to purification of pharmaceuticals, etc. Bul. PE-108.
70c *Rodney Hunt Machine Co.

Mills, Impact....available in sizes to meet individual requirements. A new bulletin tells most efficient method of achieving particle size reduction by centrifugal force.
253B Safety Industries, Enteleter Div.

Mixers....The complete line of fluid mixers range from fixed-mounted 40 H.P. turbines & heavy-duty propeller mixers to lightweight portables. Handbook offered.
240a *Eastern Industries, Inc.

Mixers....A condensed catalog showing all types of mixers and a confidential data sheet for figuring your mixer requirements are now available on request.
270b *Mixing Equipment Co., Inc.

Mixers....You'll find a wealth of information on fluid mixing in helpful bulletins describing Lightnin Mixers. They save design time, installation time & upkeep.
270a *Mixing Equipment Co., Inc.

Mixers....Literature is available on the Simpson Mix-Muller which features a unique three-way kneading, smearing, spatulate action. You get mix that stays mixed.
116 *National Engineering Co.

Mixers....built in capacities to suit any production requirement, with ready adaptability to materials handling systems. Information available.
125 *Read Standard

Mixers, Centrifugal....New principle of high speed mixing producing intimate dispersion. Available in all sizes to meet individual requirements. Bulletin offered.
253c Safety Industries, Enteleter Div.

Mixers, Gearless Pony....Fast, uniform blending of all ingredients, rugged trouble-free construction, guaranteed product protection, & a model for every need.
211 *J. H. Day Co.

*From advertisement, this issue

New Improved JERGUSON Gage Illuminator

gives up to
3 times the
illumination

Low cost explosion-proof
lighting of entire gage
glass with no glare or
blind spots

New Features:

Simplified Relamping ...
loosen one thumb screw
to lift out cover and
glass housing in one
piece.

New Safety Chain pre-
vents accidental drop-
ping.

Now both UL and CSA
Approved.



Easily mounted on back
of Transparent Gage.

The New Jerguson EPL-56 Illuminator gives three times the illumination (and 3 times the bulb life) . . . a bright, evenly diffused light over the entire length of gage glass, thus enabling you to see the liquid level clearly and easily under all conditions. Relamping is simplified: one turn of the thumb screw and you lift out cover and glass housing in one piece.

Jerguson Illuminators incorporate the principle of solid wedge lighting. Illumination from a single bulb is reflected from the angular surface of the plastic wedge and is evenly diffused through the transparent gage glass.

Jerguson Illuminators are UL approved and are built in accordance with their Standard for Electric Lighting Fixtures for use in hazardous locations for Class 1, Group D Services. They are made in a variety of sizes.

Write for Data Unit on Process Gage Illuminators.

JERGUSON

Gages and Valves for the
Observation of Liquids and Levels

JERGUSON GAGE & VALVE COMPANY

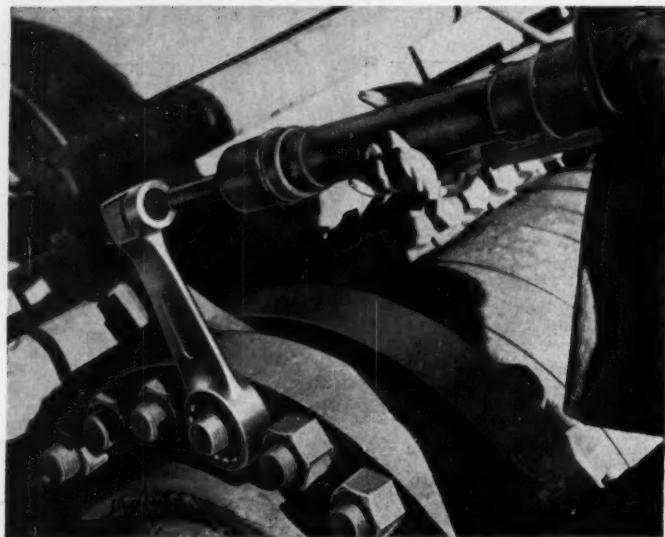
100 Adams Street, Burlington, Mass.

Offices in Major Cities

Jerguson Tress Gage & Valve Co., Ltd., London, Eng.

Pétrole Service, Paris, France

tool idea by Standard



Demonstration of wrench in action. In actual practice, a strap wrench is used in conjunction with the above wrench to prevent it from slipping from nut.

new timesaving

wrench by ***Snap-on***

Standard Oil Company of California needed a wrench to tighten bolts to high tensions... eliminate safety hazard of striking wrench with a sledge hammer... save time... overcome close-quarter limitations.

One of Standard's maintenance foremen conceived the idea of using an air-powered wrench. He outlined his thoughts to *Snap-on* sales engineer, W. F. Egbert. From their combined ideas, Standard built working models using regular *Snap-on* sledge wrenches.

Using these models, *Snap-on* made detailed drawings, then furnished the industry's first cupped-slugging wrenches. The striking surface is cupped so that a bull-nosed driver, inserted in an air-powered rivet buster, can impact the wrench from various angles to tighten the nuts. This tool answered all requirements outlined above.

Whatever your tool problems, *Snap-on* can render a specialized service. Branch offices and warehouses are located in key cities throughout the U.S. and Canada.

SNAP-ON TOOLS
CORPORATION
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LITERATURE . . .

Mixers, Top-Entering Designed for heavy-duty applications requiring agitators from $\frac{1}{4}$ to 10 H.P. Bulletin No. 620 gives the complete story.
240c *Eastern Industries, Inc.

Mixers, Turbine Bulletin 1210 contains details on these turbine mixers which solve many special mixing problems. Available in a range of $\frac{1}{4}$ to 40 H.P.
240d *Eastern Industries, Inc.

Mixers, Side-Entering Handles the extra heavy-duty jobs in big tanks. Available in sizes $\frac{1}{4}$ to 30 H.P. Complete information in Bulletin 620.
240b *Eastern Industries, Inc.

Packaged Demineralizers Brochure describes some of the special demineralizing systems offered by the manufacturer, as well as standard models for 10,000 gph. up.
254A Penfield Mfg. Co.

Processing Equipment Help in applying titanium's corrosion resistant properties to your processing equip. included in tech. data sheet on Titanium valves for chem. serv.
120 *Mallory-Sharon Metals Corp.

Screens, Vibrating Bulletin outlines the important new design and high capacities for long life under rugged conditions. Available in all sizes.
254B Safety Industries, Entoleter Div.

Thickeners "Auto-Raise" device. Has manual or power raise, replaceable ring-type ball bearing support and spiral rakes. Details in Bulletin 31-D-11.
248 *Hardinge Co., Inc.

Turbo-Film Processor has wide applications in atmospheric and low vacuum ranges. Literature is now available with details for your requirements.
70a *Rodney Hunt Machine Co.

Strainers Automatic self-cleaning strainers for efficient removal & disposal of suspended particles from raw or process water & other liquids. Bulletin 500.1C
BL255 *S. P. Kinney Engineers, Inc.

Vacu-Film Processor extends the range of thin-film processing into high vacuum . . . to one-half micron. Literature contains details for your requirements.
70b *Rodney Hunt Machine Co.

Pumps, Blowers, Compressors

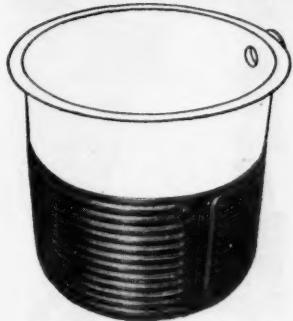
Air Equipment Information on Aftercoolers and Separators contained in Bul. #712, Bul. #117 on Poro-Stone Air Filters is also available.
R245 *R. P. Adams Co., Inc.

Air Separators circulate production loads of up to 800 tph. Nine models available with diameters from 3 to 18 ft. Information contained in Bul. 087.
R251 *Sturtevant Mill Co.

Blowers Capacities of 22 production models range from 50 to 4,000 CFM, pressures to 14 PSIG single, 70 PSIG multi stage. Full information is available.
254C M-D Blowers, Inc.

*From advertisement, this issue

NO JACKET. NO PIPE COILS.



Above you see an S.S. Kettle. More than 50 per cent of it is made of



DEAN®
THERMO-PANEL
COIL

There is NO JACKET. There are NO PIPE COILS. Heat transfer is most efficient. Construction is most economical.

You probably read, not long ago, about the explosion of an old-fashioned kettle. Steam pressure in the jacket was too high.

Complete data and prices are available on this modern Dean device which TAKES THE PLACE OF pipe coils.

Backed by 20 Years of Panel Coil Manufacturing

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More clean water at a lower cost with



AUTOMATIC
SELF-CLEANING

STRAINERS

... for efficient removal and disposal of suspended particles from raw or process water and other liquids



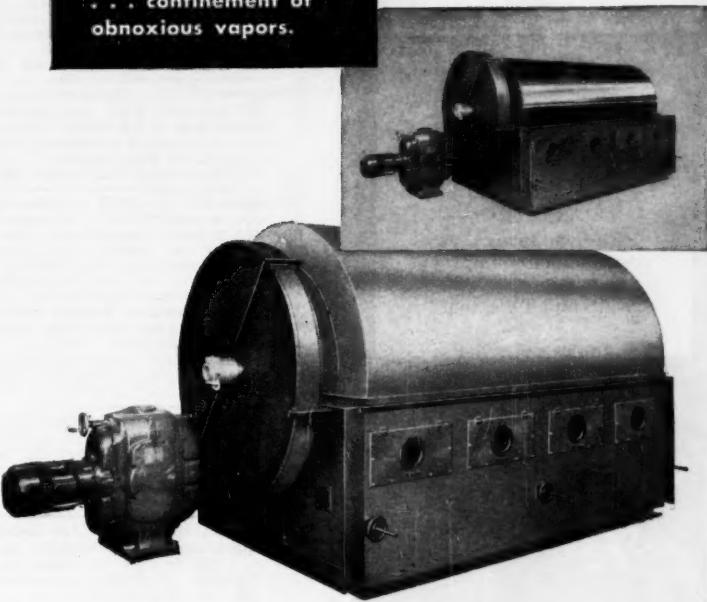
- ✓ Over 1000 installations
- ✓ 2" to 48" pipeline sizes
- ✓ Installation on pressure or suction side of pump

Write today for Bulletin 500.1C

S.P. KINNEY ENGINEERS, Inc.
CARNEGIE, PENNSYLVANIA

The Problem:

Protection against
product contamination
... confinement of
obnoxious vapors.



G-B Supplied the answer with this INTERNALLY Jacketed Flaker

The unit shown is fitted with a G-B internally jacketed fabricated drum 60" diameter by 120" long having a polished chrome plated surface. A stainless steel steam jacketed feed pan and stainless steel vapor enclosure protect against product contamination and confine obnoxious vapors.

This is another application where G-B equipment was selected. More detailed information on request.



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BIRMINGHAM, ALABAMA

FILTERS • EVAPORATORS
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CONTRACT MANUFACTURING
including HEAVY CASTINGS



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Seriously speaking...

Semiconductor devices such as transistors, diodes and rectifiers improve the performance and reliability of radios, TV sets, hearing aids, computers and missiles and also make possible many other electronic devices.

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LITERATURE . . .

Compressor..... Complete details on vertically split compressors that meet rigid design requirements is contained in Bulletin 150 which is now available.
55 *Clark Bros. Co.

Compressor..... Spiraxial Compressors are offered in two pressure ranges both with increased efficiency & higher ratings. Details in Bulletins LAH-158 & LAL-458.
121 *Roots-Conversville Blower

Compressors..... Diaphragm type compressors have no contact between gas & hydraulic fluid; gases are compressed between hydraulically-pulsed diaphragms.
227 *American Instrument Co., Inc.

Compressors..... Full details on how the advanced axial & centrifugal compressor designs can save you money on your compressed air requirements in Bul. 277-11.
8-9 *Joy Manufacturing Co.

Corrosion-Resistant Process Equipment..... Catalog describes manufacturer's complete line of resin-bonded fiber glass vessels, ducts, electors, hoods, hoppers, etc.
256A Du Verre, Inc.

Pump..... pipe line metering feed pump for metering, feeding, injection & other processes requiring positive displacement pumping. Complete information available.
BL249 *Sigmamotor, Inc.

Pump, Diaphragm..... A double-acting piston pump without packings... no leakage... easy to clean. Capable of discharge pressures to 100 psi. Bulletin 137A.
241b *T. Shriver & Co., Inc.

Pump, Double Suction..... feature sturdy, machined casing with ample, simply-formed water passages... renewable bronze wearing rings, etc. Bul. 955-S.
52 *Buffalo Forging Co

Pump, Lubricant..... The new "77" is available in high-pressure (40 to 1 ratio) medium-pressure (25 to 1 ratio) & volume delivery (6 to 1 ratio). Catalog offered.
147 *Stewart-Warner Corp.

Pumps..... non-clog pumps for pumping unscreened liquids with large solids in suspension-industrial wastes; sanitary sewage disposal. New bulletin 5440A.
238 *Fairbanks-Morse

Pumps, Acid..... available with pumping parts of the machinable alloys as well as plastic to meet all requirements. Handles corrosive liquids. Information offered.
269 *A. R. Wilfley & Sons, Inc.

Pumps, Process..... The complete range offers all types of chemical process pumps, in all sizes & frames. Bul. EM-79, "Mechanical Consideration in Pump Design" is offered.
44 *Food Machinery & Chemical Corp.

Pumps, Stock..... for pulp & paper mills are covered in revised Bul. 234. Composite dimension sheet showing SOD type pumps with standard suction nozzles.
256B *Warren Steam Pump Co., Inc.

Pumps, Sump..... Available in automatic, electric, explosion-proof, submersible & standard types in 8 models, & 20 sizes. Literature & specific engineering data offered.
242d *Penberthy Mfg. Co.

* From advertisement, this issue



HIGH EFFICIENCY

DUCLONES®

assure maximum recovery
at lowest cost

DUCLONES—Ducon high efficiency cyclones—are designed and constructed for high recovery efficiency and low gas resistance. Their sturdy construction assures long, continuous service with a minimum of maintenance.

The exceptional performance of Ducleone collectors is the result of these 6 unique features:

1. Small Diameter produces high efficiency
2. Helical Roof provides a turbulence-free path for the entering gas stream
3. Steep Cone improves dust separation
4. Dust Trap assures efficient dust removal from the cone
5. Vortex Shield prevents re-entrainment of dust in upward gas vortex
6. Scroll Outlet provides a low resistance clean gas outlet

send for Bulletin C-958.



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LITERATURE . . .

Services, Processes, Misc.

Catalytic Purifier is combined with an automatically operated drying unit to provide oxygen-free hydrogen that is ideally pure & dry. Descriptive literature offered. 14-15b *Engelhard Industries, Inc.

Fabrication Brochure "Heavy Steel Fabrication" is available on request. Outlines a wide range of products & services for the chemical & petrochemical industries. 246 *Avondale Marine Ways, Inc.

Floodlights Catalog 320 provides complete information to enable user to easily select the proper floodlight for any job. New listings and prices included. 257A Crouse-Hinds Co.

Foam Double strength foam liquid binds large volumes of air & water into fastest, most effective, lowest cost extinguishing agent for fire fighting. Details available. 141 *Rockwood Sprinkler Co.

Gas Chromatographs 2 p. application data sheet GG-91-0 explains use of laboratory gas chromatographs for plant for butadiene, ammonia, ethylene, ethylene oxide. 257B Beckman

Handbook of Chemistry New material has been added, some tables are completely rewritten, many numerical values have been changed. Lange's Handbook No. 1463.

33-34h *U. S. Industrial Chemicals Co.

High Pressure Equipment Designers & producers of valves, reactors, stirred autoclaves, pumps, pressure vessels & related equipment. Also complete package systems. 1 *Autoclave Engineers, Inc.

Hydrochloric Acid Process consists of burning hydrogen & chlorine in a bell-shaped reaction chamber at bottom of tower lined with corrosion-resistant material. 33-34 *U. S. Industrial Chemicals Co.

Processing Laboratory Small scale & semi-plant size units makes this lab the outstanding center for investigating drying, evaporating, extraction, etc. Catalog 381. 57 *Blaw-Knox Co.

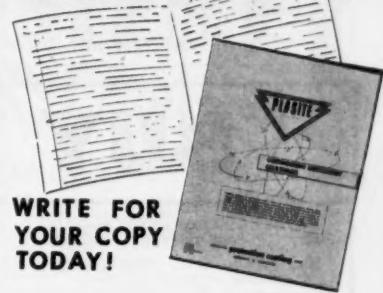
Refractories Carbofrax silicon carbide refractory has high thermal conductivity & load-bearing strength at high temperatures. Booklet, "Super Refractories." 56 *Carborundum

System, Pneumatic Conveying uses higher pressures for greater efficiency & smaller pipelines. They automatically measure quantities conveyed. Literature offered. 48 *Kennedy Van Saun Corp.

Testing Systems 16 page booklet describes the nondestructive testing systems for spotting defects in magnetic materials, nonmagnetic solids, ceramics, enamels, etc. 257C *Magnaflux Corporation

Water Service for foundation & soil sampling, well drilling & well casing & screen. Pump design, mfg., & installation. Chemical treatment of water wells. 39 *Layne & Bowler, Inc.

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- CONCRETE TANK LINING
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REPRESENTED IN PRINCIPAL INDUSTRIAL AREAS

PLASITE

*From advertisement, this issue

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CONDENSERS—TANKS

- 6—Struthers Wells 2000 gal. 316 S.S. Jacketed agitated Reactors.
- 2—Struthers Wells 1,000 gal. 316 S.S. Jacketed agitated Reactors.
- 1—1500 gal. Pfaudler, glass lined, jacketed, agitated Reactor.
- 1—500 gal. Walters, 304 S.S. jacketed, agitated Reactor.
- 1—1400 gal. Blow-Knox, steel, jacketed, agitated Reactor.
- 1—550 sq. ft. Bufflovak, monel, single effect Evaporator.
- 1—250 sq. ft. Bufflovak, 304 S.S. forced circulation Evaporator.
- 1—20 sq. ft. Bufflovak, 304 S.S. forced circulation Evaporator.
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- 1—7500 gal. 316 S.S. Vertical Storage Tank, 7' x 25', 50 PSI.
- 1—20,000 gal. 347 S.S. Vertical Storage Tank, 12' x 23'.
- 1—750 gal. nickel clad Mixing Tank, 125# internal, with nickel coils.
- 1—4000 gal. Haveg, vertical Tank, 8' x 12'.
- 1—3000 gal. Aluminum Vertical Tank 6' x 16'.
- 1—12,000 gal. horizontal steel Pressure Tank, 7/8" x 36', 200 psi.
- 2—Baker Perkins 5'6" x 6'0" Steel jacketed agitated Rotary Vacuum Dissolvers.
- 8—Stainless Heat Exchangers; 1220, 942, 786, 536, 396, 315, 250, 157 sq. ft.
- 1—24" dia. x 35', 304 S.S. Bubble Cap Column.
- 1—30" dia. x 20', 304 S.S. Bubble Cap Column.

CENTRIFUGES

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- 1—Bird 18" x 28", steel, Solid Bowl, NEW.
- 2—Sharples PY14, PN14, Super-D-Canters, 316 S.S.
- 1—Sharples H2 Nozzlejector, 15 HP, 304 S.S.
- 1—Bird 40" suspended, 317 S.S., perforated basket.
- 1—Bird 40" suspended, rubber covered, perforated basket.
- 1—Holthurst 30", 304 S.S. underdriven, perforated basket.
- 2—Sharples #16, 304 S.S., 3 HP motor

BRILL EQUIPMENT COMPANY

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2540 W. Peterson Ave., Chicago 45, Ill.

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for design, development, and technical service relating to licensing of new apparatus and process for coating and granulation. At least 3 years experience preferably in pharmaceutical industry, in process and/or equipment design is required. Knowledge of edible coating materials and solid materials handling desirable. Submit resume and present salary.

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Additional Employment Advertising

on opposite page

EMPLOYMENT OPPORTUNITIES

(Continued from opposite page)

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POSITIONS VACANT

Openings in production, research, and control in a new food processing plant being built by a large southern, AAA-concern. An opportunity to start in a fast growing industry. In reply, state complete qualification and salary requirements. P-1260, Chemical Engineering.

Manager—To manage sales, engineering and estimating division for process equipment manufacturer in East. Chemical engineering graduate preferred. Must have prior experience with manufacturer of process equipment. Excellent opening for capable, industrious manager—salary open. Send resume to P-1413, Chemical Engineering.

POSITION WANTED

Chemist: Older man chemicals, minerals, metals ferrous and non-ferrous. PW-1399, Chemical Engineering.

SALES ENGINEERS (2)

M. E. or Chemical Engineering degree. Spray Dryer Equipment. Prefer New Jersey residents. Submit complete resume indicating salary expected.

P-1308, Chemical Engineering
Class. Adv. Div., P.O. Box 12, N.Y. 36, N.Y.

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EVAPORATORS

Pfaudler 6' diameter Stainless Steel Evaporating Dishes; Jkted. Agtd. Pfaudler 4' Glass Lined Evaporators and (1) 47" diameter with Agit. Zarembo Dbl. Effect INCONEL Evaporator offering, 430 sq. ft. surface. Swenson Quadruple Effect Long Tube Film Type Evaporator. Sargent & Wilbur Ammonia Dissociator, 10,000 cu. ft. per hour. Harron Stainless Vacuum Pans, 3'x10' and 6'x12'. Harris Stainless Steel Vac. Pan, complete with coils; 6' diameter.

DRYERS

Proctor & Schwartz Apron Dryers; 8' wide S.S. Apron 5 Sections; 341/2' overall. Gehring 2 Compartment Dryers, 24"x90"x12'; 24 carts included. Buffalo Double Drum Lab. Dryer with Stainless Rolls 5"x7" in vacuum housing. Stokes Rotary Jkted. Dryers; 18"x8" and 34"x10" ASME Jkted. and Agitated. Rotary Jacketed Steel Dryer, 18"x8". Louisville Rotary Kiln; 41"x15'. Louisville Stainless Steel Rotary Dryer; 30"x28", completely equipped. Squier Rotary Atmospheric Dryer with Stainless Hexagon Shell, 30"x20'. Hersey Rotary Gas Fired Dryer 5"x26" counter current type with accessories. Stainless Lined Rotary Dryer, 30"x20" with Burner, Combustion Chamber, etc. Bagley Sewell Double Drum Dryer 28"x60" with all accessories. Buffalo Double Drum Dryer 40"x120". Carrier Silica-Gel Dehumidifier #8RG. Ft. Wayne Sterilizer 61"x124" with agitator and 5 HP motor. American Sterilizer 30"x48"x54". 2 Monel Lab. Sterilizers; 16"x24" (1) electrically heated (1) by gas.

REACTORS

Pfaudler Glass Lined Reactors up to 1000 gal. capacity; some jkted. Agtd. 2 Stainless 1000 Gal. Vert. Jkted. Vacuum Reactors Pancake coils; agitated. Special Lot of Still Pots, 30 gal. to 500 gal. in Stainless, Steel, Monel, Nickel, with Columns.

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CENTRIFUGALS

Fletcher Standard Centrifuge 12" in Stainless Steel. A.T.&M. 26" Stainless Suspended Type Centrifuge. A.T.&M. Rubber Cov. 30" Susp. Centrifugal; Ann Diesel. Tolhurst 36" S/S Suspended; with Plow and Bottom Dump. A.T.&M. 60" S/S Suspended center slung; vapor tight. Sharples S/S Super-D-Canter; 10 HP. Sharples H2 Nozzlejector; 1000 GPM. Sharples C20 Super-D-Hydrator in 316 Stainless; 20 HP. Bird Solid Bowl Continuous Centrifuge; 32"x50"; 316 S/S. Bird Stainless Steel Conical Cont. Centrifugal; 24"x38".

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RENTAL
PURCHASE
PLAN

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Baker Perkins Heavy Duty Double Pan Mixers to 300 Gal. Jacketed. NEW Falcon Double Ribbon Blenders in Stainless or Mild Steel; Now in Stock up to 140 cu. ft. Stainless Conical Blender; 22 cu. ft. motorized. Blow Knox Conical Blender; 300 cu. ft. 9'6" dia. Readco Jkted. Blender in Stainless; 18"x48". Motorized. Muller Type Batch Mixers from Simpson Lab. 11"x24" to Lancaster and Simpson 6' Diameter Mixers.

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OUTSTANDING VALUES

15-ROTARY KILNS, Dryers, Coolers, 11'x15'; 8'x12'; 8'x10'; 8'x70'; 8'x50'; 7'x60'; 5'x24'; 4'x25'; 2'x30'.
 2-STEAM TUBE DRYERS 6'x50' & 6'x25'.
 1-BUFFALO 5'x30' Rotary Vacuum Dryer.
 1-50 gal. S.S. Jktd. Agit. Reactor.
 1-DRACCO Type 32 S.S. 2600CFM Dust Collector.
 1-GAYCO 14' Air Separator.
 3-SWENSON-WALKER 24"x20" double-spiral, jacketed Crystallizers, 2HP.
 2-STOKES DDS-2 Tablet Presses.
 3-Link Belt ROTO LOUVRE DRYERS steel 502-16, 705-24; stainless 604-24.
 4-305 sq. ft. 316 STAINLESS STEEL Condensers, 156-1" x 8' tubes.
 5-CUPRO-NICKEL Heat Exchangers; 177; 346; 1035; 2330; 5200 sq. ft.
 25-Steel Heat Exchangers; 189; 880; 1042; 2060; 3900; 4420 sq. ft.
 1-INDUSTRIAL Type SS-2 STAINLESS Pressure Leaf Filter, 195 sq. ft.
 1-NAIAGARA Stainless Filter, 54 sq. ft.
 3-SWEETLAND #10, #12 Pressure Filters, Stainless and steel leaves.
 18-SHRIVER, SPERRY 12" to 42" steel, aluminum, wood Filter Presses.
 1-RAYMOND 30" dbl. Whizzer Separator.

WRITE FOR BOOKLET C459

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- 4-K-G Pug Mills, 30" dia. x 14'4".
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S. S. Reactor 1200 gal 200 lb pressure
 Baker Perkins 150 gal 40 HP, 100 gal 50 HP
 both S. S. 2 arm jacketed vacuum hydr. Mill
 100 gal Keg, 2 arm jacketed vacuum 5000 lbs.
 50 gal S. S. Autoclave 2000 lbs pressure
 Vatcleaner 60" X 9' 125 lbs.
 Sweetland 5'2 all stainless
 Stainless steel Ball Mill
 Aluminum Condenser 1000 sq. feet
 Aluminum Evaporator 1000 sq. feet
 Alumina Refractor 1000 sq. feet
 Proctor & Schwartz finned drum dryers
 Continuous Stripping columns 2 X 12 Steel
 S. S. Centrifugals 40" bottom discharge, plow
 Calenders 3 Roll 45°, 18"; 6 Roll 12" X 5"
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 Double Tier—4 Jars—No. 2
 Jars Are Stainless Steel
 Mill Is Almost New
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MILLS-Colloid—1½" US 7½ HP, 2" BAS 20 HP, PA Robinson 5 HP, Sprout Waldron 2-40 HP motors

MILLS-Harding—Conical—4½ x 16" (10 HP) pebble, 4½ x 24" (25 HP) ball, 6" x 36" (40 HP) ball, 7" x 22" (75 HP) pebble, 8" x 36" (125 HP) ball, 8" x 48" (175 HP) ball, 10" x 48" (350 HP) ball

BIN-70 cu. yd. capacity Butler w/7 x 12 Bucket elevator, weigh hopper CONVEYOR—18" x 16" Farquhar troughing, 18" x 34" apron, 18" x 37" trough, Bucket elevators to your specs.

PACKERS-St. Regis 1001S (unused), 105FV w/scales, Pneumatic Scale, Copper.

AUTOCLAVES-35 Gal. S/S jacketed, 150 Gal. steel jacketed/agitated

DRYERS-12" x 24" x 90" truck/tray, Steam—24" x 22", 33" x 18", 36" x 24", 44" x 25", 4" x 40", 5" x 40", 9" x 30" Rotary

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1—Oliver 1' x 1' stainless steel rotary vacuum filter.
 5-300 gallon stainless steel agitated autoclaves.

2—Tolhurst 40" rubber lined suspended centrifugals.
 1—Mikro atomizer #6, stainless steel.

3—35, 20, 1 gallon stainless steel jacketed double arm mixers.

1—Baker-Perkins size 16—150 gallon jacketed double arm mixer.

Chemical & Process Machinery Corp.

52 9th St. Brooklyn 15, N. Y.

HY 9-7200

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Autoclave: 50 gal. Struthers-Wells, st. st. Centrifugals: 12", 17", 20" and 26".

Clarifiers: DeLaval and Sharples, st. steel. Crystallizers: 500 gal. stain. steel. jacketed. Dewaterers: Davenport 3A, bronze hd. 3 hp. Dryer: Devine 2 x 4' vac. drum, st. steel. Dryers: Link-Belt Monotube of monel.

Filters: Elmco, Oliver, Sweetland, Alsop. Homogenizer-Dispenser: Tri-Homo #10. Kettles: St. Steel, with and without ag. Dopp 150 gal. dbl. act. agitator.

Mills: Mikro Bantam, 2TH and 24".
 Flite Comminuting model D, st. st.
 Day 14 x 30" type B hi-speed.

Colloid, 3, 5, 20, 25 hp.
 Mixers: Dbl. and Sgl. arm sigma blade. Dry Powder, various sizes.

Baker-Perkins size 17, 30 hp.
 Mixers: port. elec., side/top entering.

Mix-Muller Simpson Lab., Porto, #20.

Perculator: Pfaudler 54 x 42" st. st. jack.

Pumps: Rotary, gear, centrif. vacuum.

Reactor: Pfaudler 50 gal. gl. lined agit.

Screens 4 x 10', 40 x 84", 20 x 84", 40 x 56".

Tablet Presses: Colton #2, #4, 300 RP.

Vacuum Pcm: 42" Harris st. steel.

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 Vac Shelf, Atmos & Rotary Dryers
 Filters: Valier 49 S. S. covered leaves.
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 Dopp 350 gal. cast iron Jack. Vacuum.
 Devine Impreg. Units 30" & 36" dia.
 Steel, Alum. & Copper 5 to 2,000 gals.
 Mills: Raymond #00, 30 H.P. & #0000.
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 Pebble, Jar & Ball Mills. Lab. to 6" x 8".
 Sturtev. 1 ton Drum Blended 10 HP.
 Blystone 3000# horiz. spiral mixer.
 Dry Spiral Mixers 50 to 3000#.
 Lancashire 6" dia. 20 HP. & #1, 3 HP.
 Pumps: Stokes size Vac. 10 to 500 CPM.
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 Plastic Rubber Machy. Hydr. Presses.
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 496 CFM Vac. 14x7 CP-T(3)
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 675 CFM 100 PSI 14x13 Inv. ES PENN-3AT
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 690 CFM 125 PSI 14 1/2" x 9x7 Inv. XLE
 798 CFM 125 PSI 14 1/2" x 9x7 Inv. XLE
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- 4—Sharples C20 Super-D-Hydrators, 316 S.S.
- 2—Sharples PN14 Super-D-Canter, 316 S.S.
- 1—AT&M 26" suspended Centrifuge, perforated basket, 316 S.S.
- 2—Oliver 8" x 8" Precoat rubber covered Rotary Vacuum Filters.
- 1—Oliver 3" x 4" lead Rotary Vacuum Filter
- 4—Sperry 36" rubber covered Plate & Frame Filters, 30 chambers.
- 2—Sperry 42" Aluminum Recessed Filters, 30 chambers.
- 4—42" aluminum Recessed Filters, 36 chambers.
- 4—Shriver 36" wood Plate & Frame Filters, 44 chambers.
- 5—Struthers-Wells 8" dia. x 24' high rubber lined Vacuum Crystallizers.

PULVERIZERS AND MILLS

- 1—Mikro Pulverizer, 3TH, motor driven.
- 2—Abbe 5' x 16' brick lined Mills.
- 3—30" dia. Stainless Steel Micronizers complete with Hoppers, Conveyors, etc.

KILNS AND DRYERS

- 1—Traylor 11' x 155' Rotary Kiln, 4" shell welded, 2 tires.
- 1—Vulcan 8' x 125' Rotary Kiln, 4" shell riveted, 2 tires.
- 1—Vulcan 8' x 50' Rotary Kiln, 4" shell welded, 2 tires.
- 2—Rennenberg 6' x 60" Rotary Kilns, 4" shell riveted.
- 1—Traylor 5' x 50' Rotary Dryer, 716" shell welded, 2 tires.
- 1—Proctor & Schwartz 8' wide x 60' long Conveyor Dryer, Stainless Steel Belt.

RUBBER LINED TANKS

- 4—3400 gal. 8' x 8' with Nettco Turbo Agitators, 15 HP motors.
- 1—4000 gal. 10' x 7'6" with Nettco Turbo Agitator, 10 HP motor.
- 1—4500 gal. 9' x 9' with Nettco Turbo Agitator, 3 HP motor.
- 1—5000 gal. 9' x 10' with Nettco Turbo Agitator, 15 HP motor.
- 5—8500 gal. Vertical Storage, 8'6" x 16' x 8' cone.
- 1—10,500 gal. Horizontal Storage, 10' x 18'.
- 1—13,000 gal. Horizontal Storage 8' x 35'.

STEEL TANKS

- 4—2000 gal. 7' x 7' with Nettco Turbo Agitators, 10 HP motors.
- 1—3000 gal. 8' x 8' with Patterson Turbo Agitator, 10 HP motor.
- 1—5200 gal. 10' x 9' with Patterson Turbo Agitator, 10 HP motor.
- 15—Storage Tanks: 3800; 6000; 9000; 10,000; 15,000; 47,000 gal.

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- 3—Worthington, I.R. Compressors; 1000, 500 & 365 cfm, 30 psi.
- 4—Worthington, I.R. Vacuum Pumps, 1000 and 500 cfm.
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- 2—Shepard Niles 20 ton Overhead Cranes.
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- 1-Stainless Steel Heat Exchanger, 390 3/4" I.D. tubes 10' long
- 2-J. H. Day 150 gallon Sigma Mixers, size 40 Imperial type. Power tilt
- 1-Combustion Engineering Water Tube Boiler, 12,000# steam per hour. 150 PSI. New
- 4-Haveg Vertical Tanks, 2-1250 gallon, 2-2000 gallon type 61 Haveg. Closed top with manhole
- 12-1000 gal. Steel. Horiz. Pressure Tanks. 275 PSI code constructed. Last used Anhydrous Ammonia
- 1-Steel Fractionating Column. 42" O.D. x 70', 28 trays. 30 PSIG
- 1-Raymond 5 Roller Low Side Mill, with Cyclones, Fans. Extra parts
- 3-3500 S.S. horizontal Glascote Tanks. Closed with Agitators
- 1-J. H. Day 14" x 30" Roller Mill, hi speed-two speed, 25-12½ HP mtr drive. Rebuilt

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APRIL 6 ISSUE
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BP 100 gal. Jkt'd. Mixer Cored Sigma arms
Nash Hytor Vac. Pump #6, with 40 H.P. motor
Day 40 gallon Pony Mixer with AC motor
Patterson 6"x5' Jkt'd. Ball Mill, exp. pf. mtr.
Devine Vac. Shelf Dryer, 59x78, double door
Gen. American 42"x120" Twin Drum Dryer

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- 1—Kent 20 gal. "Super" pony mixer with 3 HP explosion proof motor
- 10—Alco type 316 SS jacketed 3000 gal. reactors, complete with turbine agitators and drives
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THE GELB GIRL—APRIL 1959

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- 1—Columbia Engineering high pressure storage tanks, 2400 gal., 265# working pressure
- 1—Dover Tank Co. horizontal 4000 gal. nickel tank, 30 psi
- 3—Picudler type 316 SS 700 gal. jacketed kettles with condensers, columns and receivers.
- 2—Picudler 400 gal. types 316 SS jacketed reactors
- 4—2500 gal. SS vertical tanks
- 1—5700 gal. SS storage tanks

DRYERS

- 1—Proctor & Schwartz 2 truck dryer with SS trays
- 4—Link Belt steel roto louver dryers, Model 207-10, 310-16, 310-20, 604-20
- 1—Link Belt steel roto louver dryer, Model 1003-30, complete
- 1—Buflovak double drum dryer 42" x 120"
- 1—Stokes Model 59DS steel rotary vacuum dryer, 5' x 30'
- 1—Stokes double drum dryer, 5' x 12'
- 1—Louisville rotary steam tube dryer, 8' x 45'
- 1—Louisville SS rotary kiln, 30" x 28' complete
- 1—Stokes SS rotary vacuum dryer, 2' x 6'
- 6—Stokes steel jacketed rotary vacuum dryers, 3' x 15'
- 1—Louisville SS rotary dryer, 8' x 50'
- 1—Louisville rotary dryer, 38" x 40' Type L

FILTERS

- 1—Oliver horizontal filter, 6'6"
- 1—Sweetland #3 SS filter
- 1—Niagara SS filter Model 510-28
- 1—Oliver horizontal filter, 3'
- 1—Feinc SS rotary vacuum string filter, 3' x 3' (NEW)
- 10—Shriver plate and frame filter presses, 12" to 42"
- 12—Sweetland #12 filters with 72 SS leaves
- 1—Shriver rubber lined filter press, 36" x 36"

MIXERS

- 1—Patterson jacketed vacuum SS kneader master mixer sigma blades, 300 gal. working capacity
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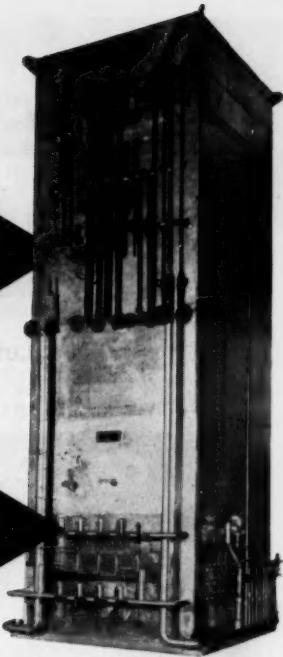
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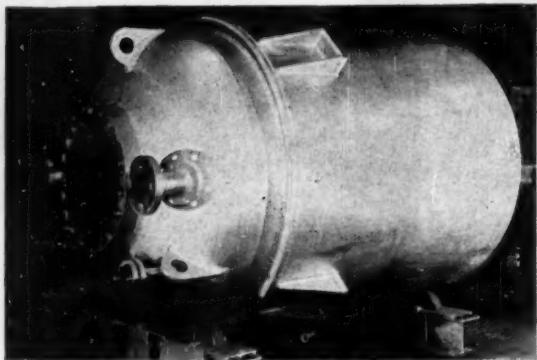
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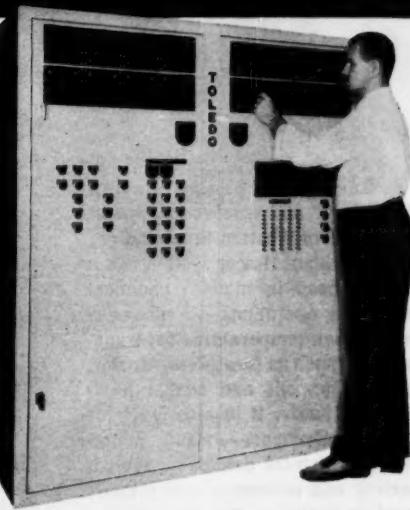
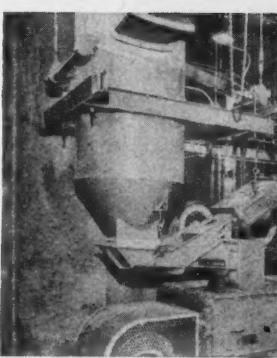
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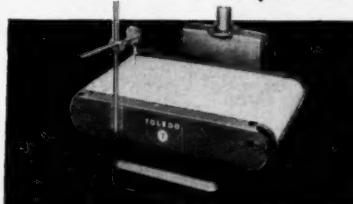
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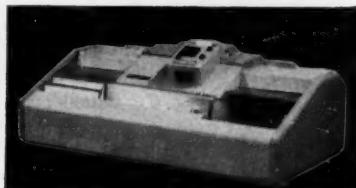
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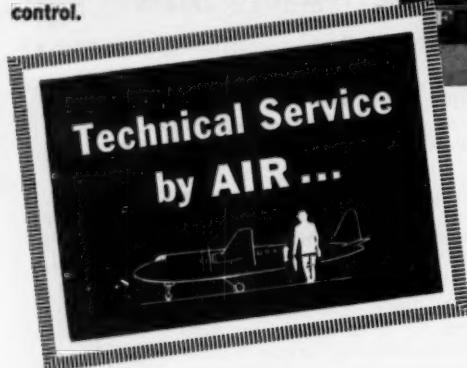
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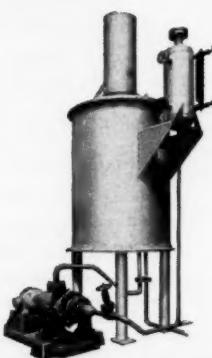
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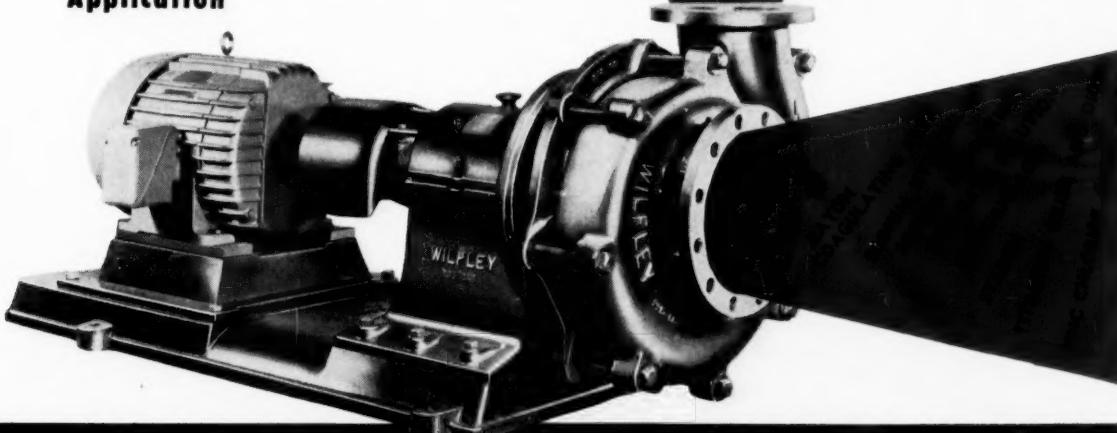
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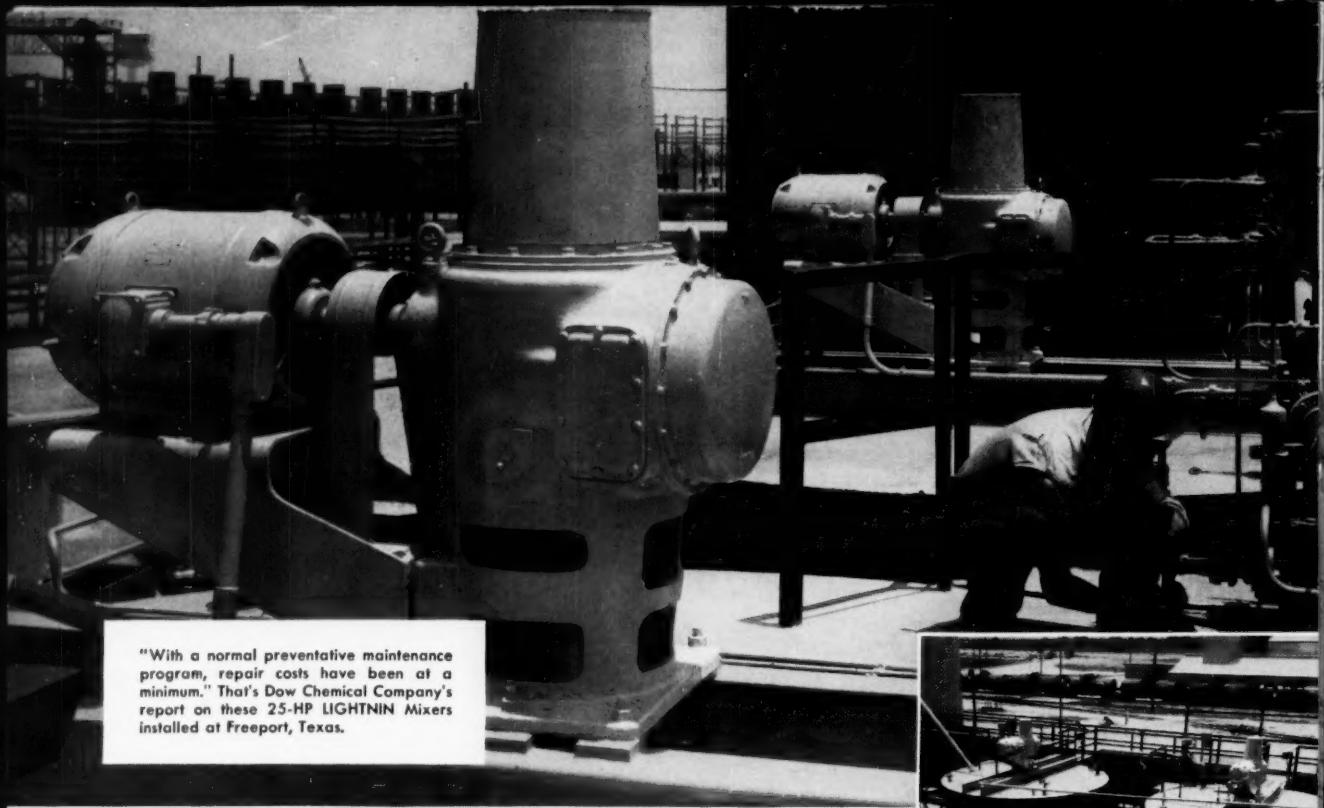
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How Dow holds mixing costs in line

Take a look at the size of Dow Chemical Company's Freeport, Texas, caustic soda plant—and you'll see why low operating costs for mixing equipment are vital.

No special research had to be done to determine what size mixers would handle this job best. Mixers were selected on the basis of unique pilot-run data on tap at MIXCO. Mixing results were fully predictable, and unconditionally guaranteed.

No steady bearings

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Get these 3 vital savings

These economies are yours, too, when you choose LIGHTNIN for your fluid mixing operations.

You save design time with application data that's guaranteed accurate.

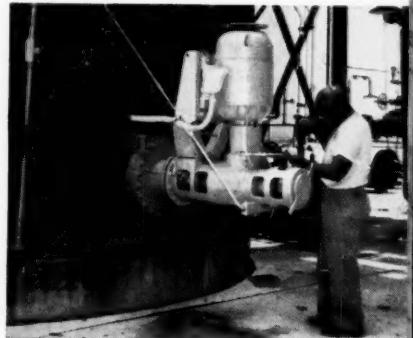
You save installation time because every LIGHTNIN reaches you as a "package," ready to install and run.

You keep saving on upkeep, with a host of mechanical features that minimize your service costs.

To get these savings for your processing, call in your LIGHTNIN Mixer representative. He's listed in Chemical Engineering Catalog. Or write us direct.



PRIOR TO PURIFICATION, caustic is kept at uniform temperature, with help of mixing, in each of six 30,000-gallon tanks like these. LIGHTNINs also suspend sediment uniformly for easier removal.



DOW GETS LOW-COST MIXING in this 75,000-gallon caustic tank with a 25-HP side-entering LIGHTNIN. Stuffing box can be repacked simply and quickly. To seal off tank fluids for repacking, maintenance man turns easy-to-get-at handles at outboard end of mixer.

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